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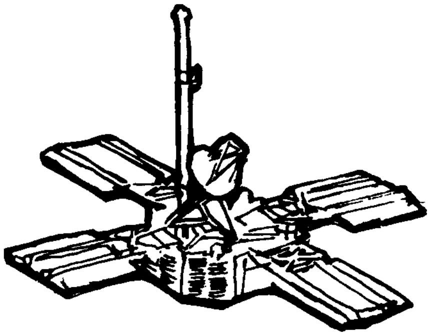

PROJECT: MARINER E/VENUS 67

(To be launched no earlier than June 12)

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5/24/67

NEWS NASA

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MARINER/VENUS

SET FOR JUNE

LAUNCH AT CAPE

A 540-pound Mariner spacecraft will be launched from Cape Kennedy, Fla. no earlier than June 12 on a four-month-long mission to Venus.

Mariner's trajectory will take it to within some 2,000 miles of Venus on Oct. 19, about ten times closer to the planet than Mariner II in Dec. 1962. Mariner's looping flight to Venus will cover 212.5 million miles.

Primary objective of the Mariner Venus 1967 mission is to obtain scientific information on the origin and nature of Venus and its environment. Although it is the closest planet to Earth, Venus is largely an unknown planet because of its thick cloud envelope.

The Venusian atmosphere itself is a mystery with theories of its density, for instance, ranging from five to several hundred times the density of the Earth's atmosphere.

The Mariner Venus mission also will gather information on the interplanetary environment during a period of increasing solar activity. Flight time to Venus will vary from 114 to 130 days depending upon the day of launch.

5/24/67

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The launch period covers a period of about two weeks beginning June 12. An opportunity to launch to Venus comes once every 19 months.

An Atlas-Agena D vehicle will launch the Mariner Venus 67 mission from Cape Kennedy Complex 12.

Before modification, the spacecraft being prepared for this mission was a backup to Mariner IV which, in July 1965, flew within 6,200 miles of Mars, took 22 photographs of the planet, and obtained other scientific data.

Major changes in the spacecraft required by a flight toward rather than away from the Sun include the reversal and reduction in size of the solar panels; the addition of a thermal shield on the Sunward side of Mariner's octagonal spaceframe; and relocation of science instruments and sensors.

Other changes from the Mariner IV design are required by trajectory characteristics and a new lineup of scientific experiments. They include a new data automation system for preparing scientific information for transmission to Earth; a two-position high gain antenna; removal of the scan platform on which Mariner IV's camera was mounted; and the addition of antennas and receivers to accommodate the dual-frequency occultation experiment.

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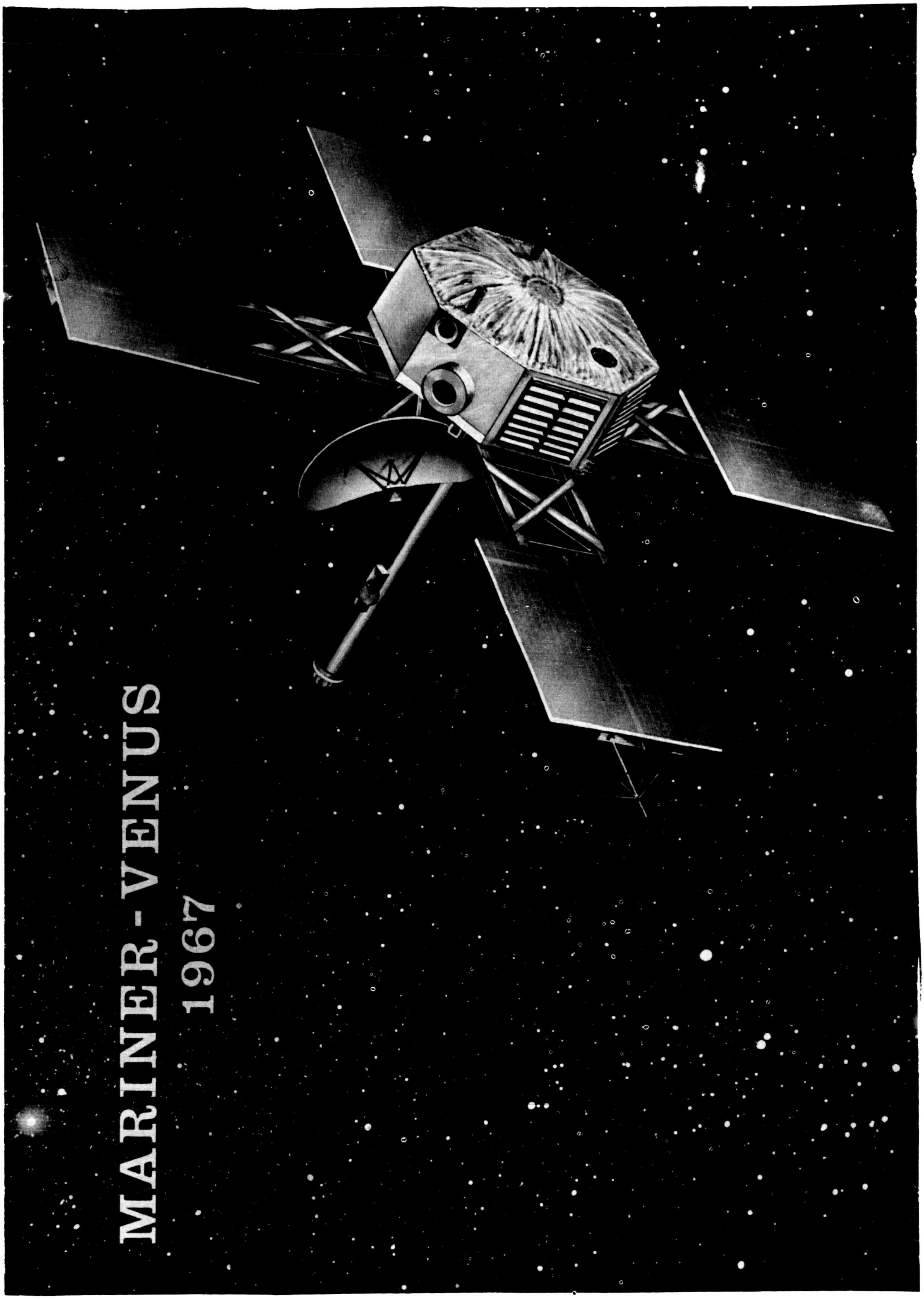

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The interplanetary science payload will include instruments similar to those carried to Mars by Mariner IV. A solar plasma probe, a trapped radiation detector and a helium vapor magnetometer will report on radiation and magnetic fields from Earth to Venus and beyond.

At Venus, the S-band and dual-frequency occultation experiments will provide data on the properties of the atmosphere and the ultraviolet photometer will measure two elements -- atomic hydrogen and atomic hydrogen and atomic oxygen -- in the upper Venusian atomsphere. Temperature may be deduced from these measurements.

By correlating orbital information from Mariner Venus 67 with that from Mariner II, celestial mechnaics experimenters will be able to increase the accuracy of the following values: mass and ephemeris of Venus; mass of the Moon; ephemeris of Earth; and the astronomical unit (Earth-Sun distance).

The close approach of Mariner to Venus will have a radical effect upon the spacecraft's orbit which, after fly-by, will bring it closer to the Sun than any previous mission.

An attempt will be made to track Mariner as long as possible after the Venus encounter because every additional day of telemetry received and analyzed may mean further refinement of our knowledge of the solar system.

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Mariner Venus 67 will be redesignated Mariner V upon successful launch. The spacecraft stands 9½ feet high and spans 18 feet with solar panels extended. Solar panel surface area totals 43½ square feet, a reduction from 70 square feet on Mariner IV.

The 67 Venus mission will be conducted by substantially the same National Aeronautics and Space Administration-Jet Propulsion Laboratory team that conducted the 1964 Mars mission. This team also will conduct the continuation of data acquisition from Mariner IV during 1967.

For NASA, the Mariner Venus 67 mission is managed by Lunar and Planetary Programs of the Office of Space Science and Applications.

Project management as well as responsibility for the spacecraft, mission operations, and tracking and data acquisition is assigned to the Jet Propulsion Laboratory, Pasadena, Cal., which is managed for NASA by the California Institute of Technology.

Atlas-Agena project management is assigned by OSSA's Launch Vehicle and Propulsion Programs at NASA's Lewis Research Center, Cleveland. The launch will be conducted by the John F. Kennedy Space Center's Unmanned Launch Operations team.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

MARINER VENUS 67 SPACECRAFT

Mariner's basic structure is a 32-pound, eight-sided magnesium framework with seven electronics compartments. The midcourse rocket propulsion system occupies the eighth compartment. The compartments themselves provide structural support to the spacecraft.

Four spar structures supporting four solar panels are attached to the top of the octagon in a + pattern with the octagon at the center of the +. The panels, 44½ inches long and 35½ inches wide, are mounted at the outboard ends of the structures with their cell surfaces facing downward, or Sunward.

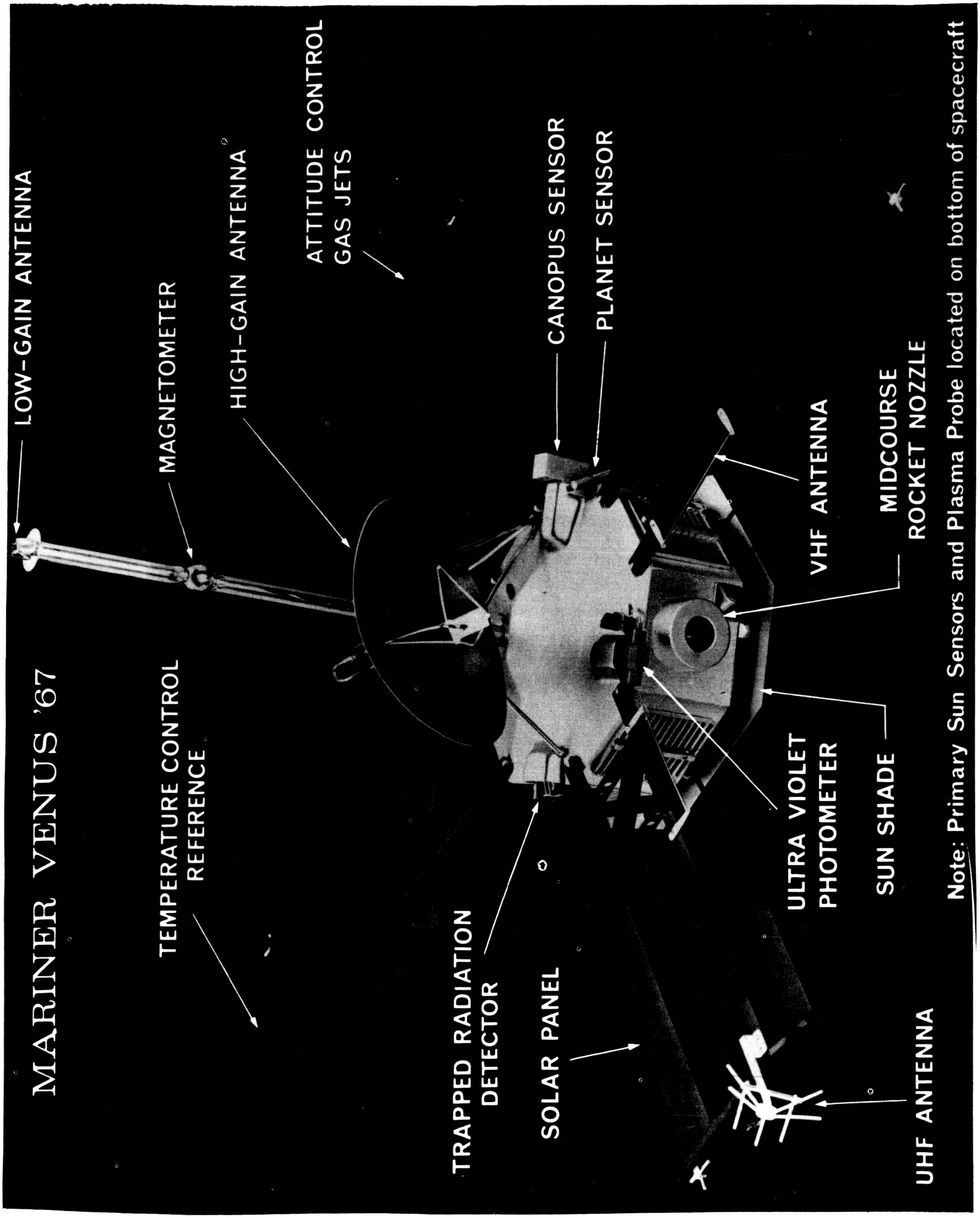
Two sets of attitude control jets consisting of six jets each, which stabilize the spacecraft on three axes, are mounted on the ends of the solar panels for maximum torque. Extending beyond the jet manifolds on three of the panels are keyhole-shaped temperature control reference units. The fourth panel supports a special antenna for the dual frequency radio propagation experiment.

The interior of the octagon contains gas bottles and regulators for Mariner's dual attitude control gas system. The propellant tank for the liquid-fuel midcourse motor is supported by a cantilever arrangement inside the octagonal cavity, with the rocket nozzle protruding through one of the eight sides of the spacecraft.

The high-gain directional antenna is attached to the spacecraft by a seven-legged superstructure atop the octagon. Its honeycomb dish reflector is an ellipse, 46 inches by 21 inches, and is parabolic in cross-section. The antenna will have two positions, each of which is fixed with respect to the spacecraft. The first position will be employed from launch until it is irreversibly up-dated to the second position during occultation at Venus. The low-gain omni-directional antenna is mounted on the end of a circular aluminum tube, 3.88 inches in diameter and rising 88 inches from the top of the octagonal structure. The tube acts as a waveguide for the low-gain antenna.

The Canopus star sensor assembly is located in the shade of the spacecraft on the upper ring structure of the octagon for a clear field of view. Two primary Sun sensors are mounted on pedestals about four feet apart on the bottom of the spacecraft. Secondary Sun sensors, Earth sensor, planet sensor and Venus terminator sensor are attached to the top of the octagon.

The eight compartments girdling the spacecraft house the following: Bay 1, power inverters and synchronizer, battery charger and pyrotechnic control assembly; Bay 2, midcourse


MARINER VENUS '67
LOW-GAIN ANTENNA
MAGNETOMETER
HIGH-GAIN ANTENNA
ATTITUDE CONTROL GAS JETS
CANOPUS SENSOR
PLANET SENSOR
VHF ANTENNA
MIDCOURSE ROCKET NOZZLE
TEMPERATURE CONTROL REFERENCE
TRAPPED RADIATION DETECTOR
SOLAR PANEL
ULTRA VIOLET PHOTOMETER
SUN SHADE
UHF ANTENNA
Note: Primary Sun Sensors and Plasma Probe located on bottom of spacecraft

maneuver rocket engine; Bay 3, science equipment and data automation system; Bay 4, data encoder (telemetry) and command subsystems; Bays 5 and 6, radio receiver, transmitters and tape recorder; Bay 7, central computer and sequencer, gyros and attitude control electronics; Bay 8, power booster regulator and spacecraft battery.

Six of the electronics compartments are temperature-controlled by light-weight louver assemblies on the outer surfaces. The octagon's interior is insulated by multi-layer aluminized plastic thermal shields at both top and bottom of the structure. A deployable Sun shade complements the bottom shield by forming an octagonal awning beyond the periphery of the spacecraft structure on the Sunlit side.

The Mariner spacecraft will carry scientific instrumentation for five interplanetary and planetary experiments. Two other experiments -- S-band occultation and the celestial mechanics experiments -- use only the spacecraft's radio subsystem and the Doppler data derived from the radio signal.

The helium magnetometer attaches to the low-gain antenna support boom at a point about five feet above the body of the spacecraft. The trapped radiation detector and ultraviolet photometer are mounted on the upper octagonal ring, on the side of the spacecraft away from the Sun, each with a field of view between a pair of solar panels. The solar plasma probe looks directly at the Sun through the lower octagonal ring. One of the trapped radiation detector's four detecting tubes also points at the Sun through an aperture in the sunshade.

One of the compartments protected by louvers -- Bay 3 -- contains the electronics for the above instruments as well as the dual frequency receiver (DFR). The DFR requires two antennas apart from those used for spacecraft telemetry and tracking data. The DFR antenna for the UHF (423.2 megacycles) channel is mounted at the outboard end of one of the four solar panels. Two adjacent solar panel structures act as the antenna for the DFR 49.8-megacycle channel.

The Mariner weighs 540 pounds and measures 9½ feet to the top of the low-gain antenna. With solar panels extended, the spacecraft spans 18 feet. The octagonal structure is 50 inches across.

Power

Primary power source for the Mariner spacecraft is an arrangement of 17,640 photovoltaic solar cells mounted on four panels which will face the Sun during most of the flight to Venus. The cells, covering 43.6 square feet, will collect energy from the Sun and convert it into electrical power.

A rechargeable silver-zinc battery will provide spacecraft power during launch, midcourse maneuver and whenever the panels are turned away from the Sun. The battery will be kept in a state of full charge and will be available during planet encounter as an emergency power backup source.

Two power regulators will divide the power load and provide redundancy. In the event of a failure in one, it will be removed automatically from the line and the second will be switched in to assume the full load.

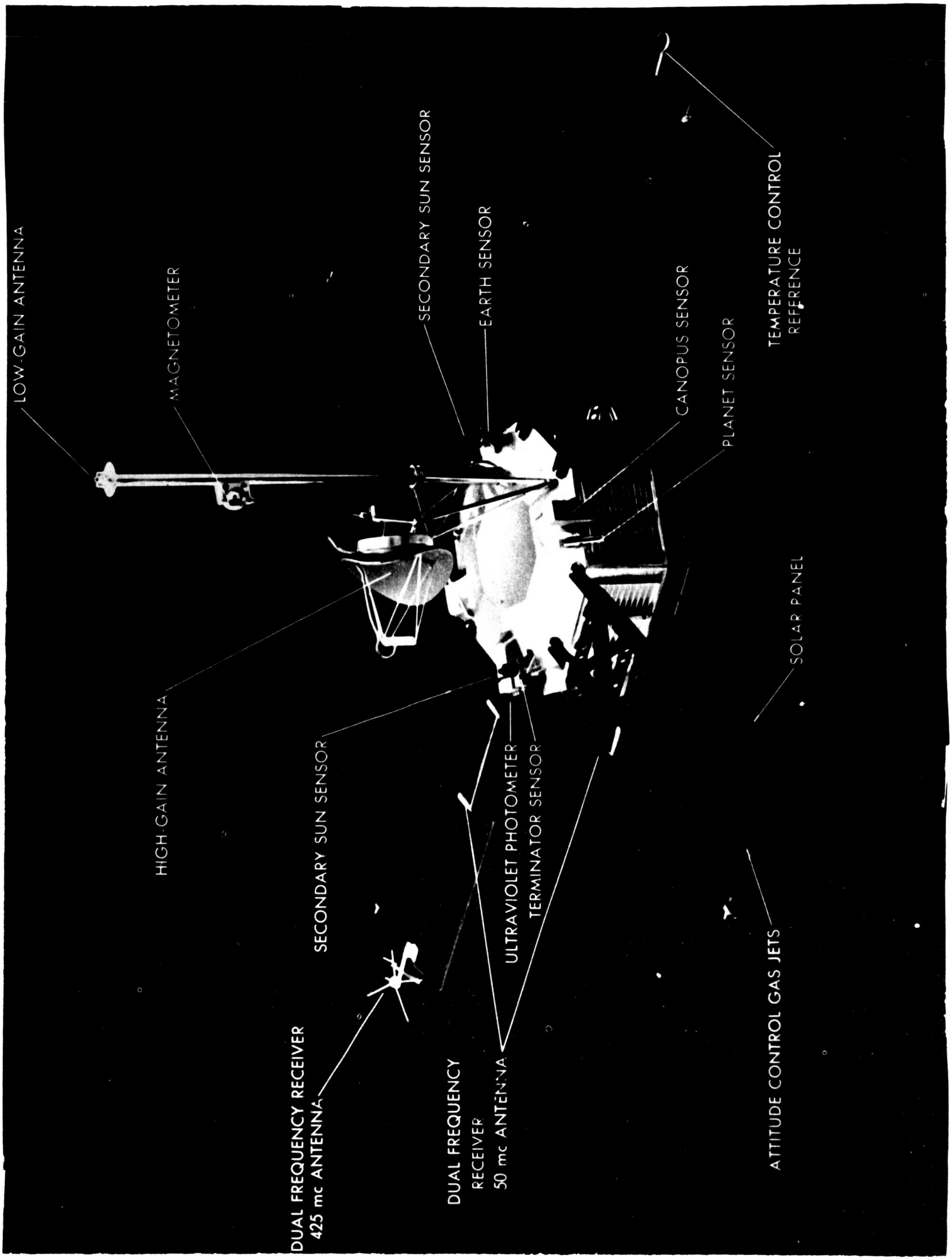
The solar panels will be folded in a near vertical position above the spacecraft during launch and will be deployed after separation from the launch vehicle. Each panel weighs 15.6 pounds, including the weight of solar cells and protective glass filters that reduce the amount of solar heat absorbed without interfering with the energy conversion. Lightweight panel structures that support the cells are made of thin-gauge aluminum approximately the thickness of kitchen foil. Panels are constructed of .005-inch aluminum sheet formed into a corrugation that is bonded to the the cell-mounting surface also made of .005-inch sheet.

Normal power from the panels is expected to be 370 watts at maximum power voltage for cruise conditions in space near Earth. This power capability increases to about 550 watts at Venus encounter. Total power demands during the mission range from about 180 watts during launch to 281 watts during a midcourse maneuver.

The battery is a sealed unit containing 18 silver-zinc cells. Its minimum capacity ranges from 1200 watt hours at launch to about 900 watt hours at planet encounter. Load requirement on the battery may vary between zero amps and 9.5 amps with battery voltages expected to vary from 25.8 to 33.3 volts. The battery weighs 33 pounds.

The battery will be capable of delivering its required capacity and meeting all electrical requirements within an operational temperature range of 50° to 120° F. At temperatures beyond these limits, it will still function although its capability will be reduced.

To insure maximum reliability, the power subsystem was designed to limit the need for battery power after initial Sun acquisition. Except during maneuvers, the battery will remain idle and fully charged.


LOW-GAIN ANTENNA
MAGNETOMETER
SECONDARY SUN SENSOR
EARTH SENSOR
CANOPUS SENSOR
PLANET SENSOR
TEMPERATURE CONTROL
REFERENCE
SOLAR PANEL
ATTITUDE CONTROL GAS JETS
HIGH-GAIN ANTENNA
SECONDARY SUN SENSOR
ULTRAVIOLET PHOTOMETER
TERMINATOR SENSOR
DUAL FREQUENCY RECEIVER
425 mc ANTENNA
DUAL FREQUENCY
RECEIVER
50 mc ANTENNA

Under normal flight conditions, the primary power booster-regulator will handle all cruise and encounter loads. A second regulator will support power loads during maneuvers. Should an out-of-tolerance voltage condition exist in the cruise regulator for 3.5 seconds or longer, the maneuver regulator will take its place on the line.

Primary form of power distributed to other spacecraft systems is 2,400 cycles-per-second square wave. The gyro spin motors use 400 cps three-phase current. The tape recorder motor is supplied with 400 cps single-phase current during the launch phase of the flight, 2,400 cps power for recording at encounter and 400 cps power during data playback. The magnetometer heater and the power amplifier portion of the transmitter will receive raw power from the solar panels or the battery.

Telemetry measurements have been selected to provide the necessary information for the management of spacecraft power loads by ground command if necessary.

The battery, regulators, and power distribution equipment are housed in two adjacent electronics compartments on Mariner's octagonal base.

Communications

Two-way communication with the Mariner will be accomplished with a radio link between Earth tracking stations and a dual transmitter-single receiver radio system aboard the spacecraft.

The on-board communication system also includes a telemetry subsystem (data encoder), command subsystem, tape recorder and high and low-gain antennas.

Communications will be in binary digital form. Radio command signals transmitted to Mariner will be decoded--translated from the binary form into electrical impulses--in the command subsystem and routed to their proper destination. Mariner is capable of accepting 29 direct commands and one quantitative command. The latter is a three-segment command for midcourse trajectory maneuver and is stored in the central computer and sequencer until required.

Data telemetered from the spacecraft will consist of engineering and science measurements prepared for transmission by the data encoder. The encoded information will indicate voltages, pressures, currents, temperatures, and other values measured by the spacecraft telemetry sensors and scientific instruments.

The 100-channel telemetry subsystem can sample 90 engineering and science measurements and can operate in four sequences in which the data transmitted are (1) engineering only during maneuvers; (2) a mix of two-thirds science and one-third engineering data during launch and cruise; (3) all science at planet encounter with brief insertions of engineering at a ratio of about three parts engineering to 100 parts science; and (4) stored science data played back from the tape recorder after Venus encounter with periodic insertions of real time engineering measurements.

During cruise, engineering data and most science data will be transmitted in real time. During the two-hour period covering closest approach to Venus, all of the science data will be stored by the tape recorder. Simultaneously, the encounter science data compatible with the telemetry bit rate (8 1/3 bits per second) will be transmitted in real time.

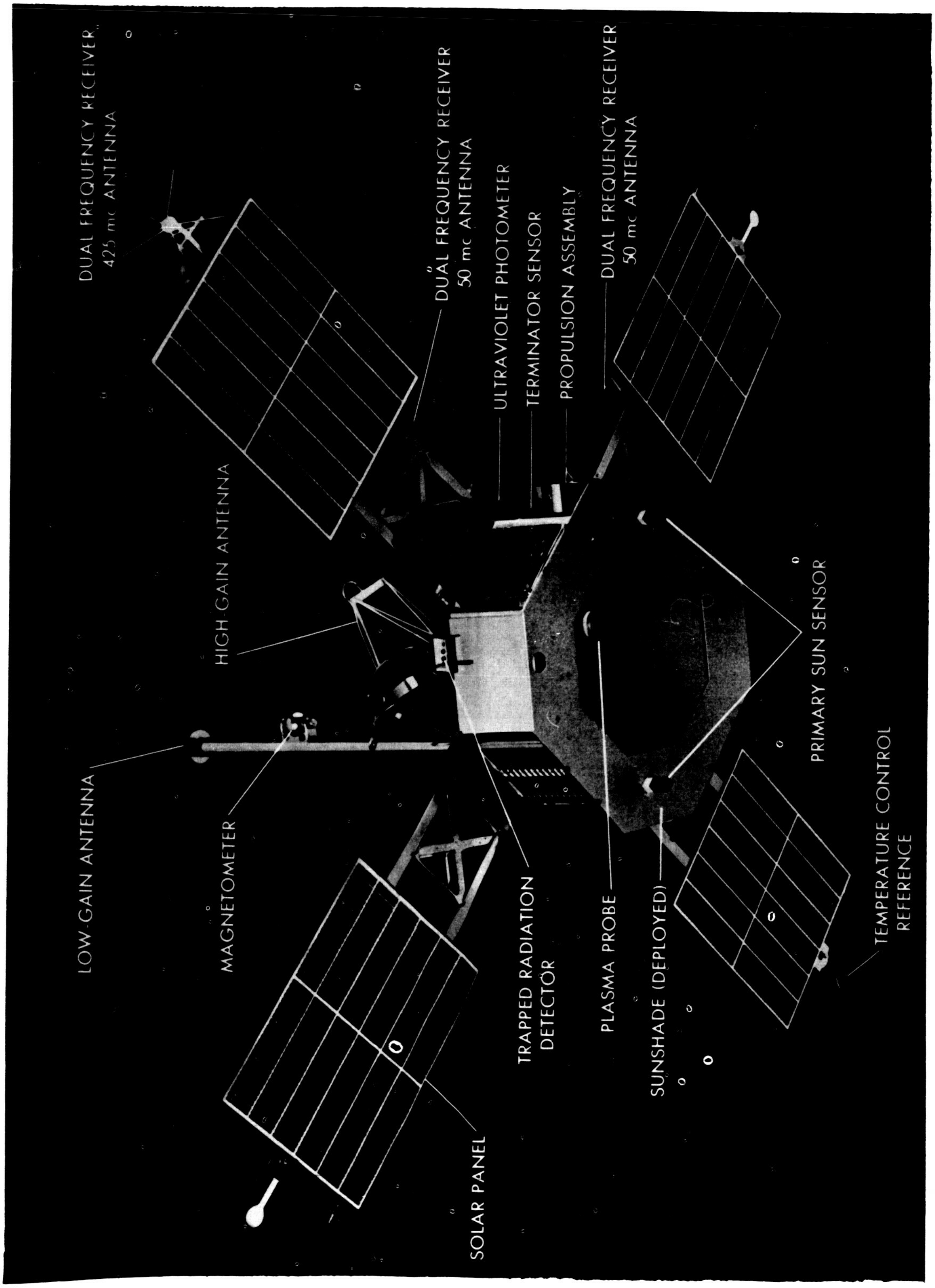
Purpose of the four-sequence operation of Mariner's telemetry subsystem is to obtain the maximum available sampling rate on measurements required during a particular phase of the mission by not transmitting less useful information during that period.

Mariner can transmit information to Earth at two rates -- 33 1/3 bits per second and 8 1/3 bits per second. The greater rate will be used for as long as the signal level from the spacecraft is high enough to allow good data recovery. Switching to the lower rate normally is commanded by the central computer and sequencer about 30 days after launch. The automatic switchover is backed up by ground command. A ground command is available also to switch the telemetry rate back to 33 1/3 bits per second, but its use is unlikely during this mission.

Synchronizing pulses will be spaced at regular intervals between the data signals from Mariner. Ground-based receiving equipment will generate identical pulses and match them with the pulses from the spacecraft. This will provide a reference to determine the location of the data signals, allowing receiving equipment to separate data signals from noise.

The spacecraft S-band receiver will operate continuously during the mission at 2116 mega hertz. It will receive Earth commands through either the low-gain antenna or the high-gain antenna.

The low-gain antenna, providing essentially uniform coverage in the spacecraft hemisphere facing away from the Sun, will provide the primary path for the Earth-to-spacecraft radio link. Switchover to the high-gain antenna and back to the low-gain, if desired, may be commanded from Earth.


DUAL FREQUENCY RECEIVER
425 mc ANTENNA
DUAL FREQUENCY RECEIVER
50 mc ANTENNA
ULTRAVIOLET PHOTOMETER
TERMINATOR SENSOR
PROPULSION ASSEMBLY
DUAL FREQUENCY RECEIVER
50 mc ANTENNA
HIGH GAIN ANTENNA
PRIMARY SUN SENSOR
LOW-GAIN ANTENNA
MAGNETOMETER
TRAPPED RADIATION
DETECTOR
PLASMA PROBE
SUNSHADE (DEPLOYED)
TEMPERATURE CONTROL
REFERENCE
SOLAR PANEL

The transmitting subsystem consists of two redundant radio frequency power amplifiers and two redundant radio frequency exciters of which any combination is possible. Only one exciter-amplifer combination will operate at any one time. Selection of the combination will be by on-board logic with ground command backup.

The two power amplifiers will operate at a nominal output of seven watts for the grounded grid cavity amplifier and 10 watts for the traveling wave tube amplifier. Transmitter frequency is 2,298 megacycles.

The operating transmitter can be connected to either antenna. Switchover will occur on command from the central computer and sequencer with ground command backup. Transmission via the high-gain antenna will be required for approximately the final 30 days before encounter. Attitude of the spacecraft will be such that the high-gain antenna is pointed toward Earth during this portion of the mission.

Because of the expected extreme density of the Venusian atmosphere which will bend the path of the spacecraft radio signal, the high-gain antenna will have two positions to counteract the bending at the planet and keep the signal aimed at Earth. The first position will be employed until the period of occultation (when the spacecraft is hidden from Earth by Venus). As the Venus terminator -- the line separating the sunlit and darkened portions of the planet -- comes into the terminator sensor's field of view, a signal is generated to shift the antenna by about 18 degrees. The antenna can be shifted only once and cannot be returned to the original angle.

The tape recorder uses 50 feet of magnetic tape in an endless loop. Science measurements formatted by the data automation system are recorded simultaneously on two tracks at 66 2/3 bits per second. Tape speed for recording is .08-inch per second. Playback of the data after the spacecraft passes the planet will take approximately 36 hours at a rate of 8 1/3 bits per second. Playback is from one track at a time at a tape speed of .01-inch per second.

Midcourse Propulsion

Mariner's midcourse rocket engine is a liquid monopropellant engine capable of firing twice during the Venus mission. Its function is to provide small trajectory corrections to the spacecraft. The engine uses anhydrous hydrazine as the propellant and uses nitrogen tetroxide as the starting fluid.

The rocket nozzle protrudes from one of the eight sides of Mariner's octagonal base below and between two of the solar panels. The engine's direction of thrust is nearly parallel to the panels, hence perpendicular to the longitudinal or roll axis of the spacecraft.

Hydrazine is held in a rubber bladder contained inside a spherical pressure vessel. The propellant is forced into the combustion chamber by nitrogen gas compressing the bladder. Decomposition of the hydrazine, maintained by a catalyst stored in the chamber, causes the rapid expansion of hot gases in the engine.

Firing of the engine is controlled by the central computer and sequencer, which receives the time, direction and duration of required thrust through the ground-to-spacecraft communication link. At the command signal from the CC&S, explosively-actuated valves allow pressure-regulated nitrogen gas to enter the fuel tank, open the propellant line to the engine and inject the starting fluid. A timer shutoff mechanism in the CC&S actuates another set of valves which stops propellant flow and fuel tank pressurization. During rocket engine firing, spacecraft attitude is maintained by autopilot-controlled jet vanes positioned in the rocket nozzle to deflect the engine exhaust stream.

Re-start capability and redundancy are provided by second sets of explosive start and shutoff valves. The second midcourse maneuver may or may not be required.

The midcourse motor can burn for as little as 50 milliseconds and can alter velocity in any direction from less than 1/8 mile per hour to 188 miles per hour. Maximum burn time is 100 seconds. Thrust is continuous at 50.7 pounds.

Launch weight of the midcourse propulsion system, including the gas pressurization unit and 21½ pounds of fuel, is 51 pounds.

Attitude Control

Stabilization of the spacecraft during the cruise and planet encounter portions of the Mariner Venus mission is provided by a system of 12 cold gas jets mounted at the outer ends of the four solar panels. The jets are linked by logic circuitry to three gyroscopes (one gryo for each of the spacecraft's three axes), to the Canopus sensor and to the primary and secondary Sun sensors.

The gas system is divided into two self-contained redundant sections and each contains six jets and is complete with its own gas supply, regulators, lines and valves so that a leak or valve failure will not deplete the gas and jeopardize the mission. Each system is fed nitrogen gas from a titanium bottle containing 2.5 pounds of gas pressurized at 2470 pounds per square inch.

Normally, both gas systems will operate during the mission. Either system can support the entire flight in the event of a failure in the other.

Because of high temperatures expected on the Venus mission, the gas system is designed to operate in the temperature range of -45° to $+215^{\circ}$ F.

The primary Sun sensors are mounted on the sunlit side of the spacecraft and the secondary sensors on the shadowed side. The sensors are light-sensitive diodes which inform the attitude control system when they see the Sun. The attitude control system responds to these signals by turning the spacecraft and pointing the solar panels toward the Sun for stabilization on two axes and for conversion of solar energy to spacecraft power. Nitrogen gas escapes through the appropriate jet nozzle, imparting a reaction to the spacecraft to correct its angular position.

The star Canopus, one of the brightest in the galaxy, will be used to point the high-gain antenna toward Earth and to provide a second celestial reference (in addition to the Sun) upon which to base the midcourse maneuver. The Canopus sensor will activate the gas jets to roll the spacecraft about the already-fixed longitudinal or roll axis until it is "locked" in cruise position. Canopus acquisition occurs when the light intensity in the field of view of the sensor is greater than one-half that of the star Canopus. Brightness of the sensor's target will be telemetered to the ground to verify the correct star has been acquired.

At approximately two months prior to encounter, the Canopus sensor will be updated to compensate for the changing angular relationship between the spacecraft and the star. The sensor's field of view or "look angle" will be changed electronically to follow Canopus throughout the flight. The update, which will occur four times at approximately two-week intervals, will be commanded at predetermined times by the on-board central computer and sequencer with ground command backup.

Because a Canopus sensor failure prior to midcourse maneuver probably would preclude the maneuver, an Earth sensor is used to provide a roll reference backup. The Earth may be used as a crude roll reference to fix the spacecraft's position for a maximum of 20 days after launch. A secondary function of the Earth sensor provides a possible aid in Canopus identification. If the Earth comes into the field of view during the Canopus acquisition sequence, it will be indicated in the telemetry. With the known geometrical relationship between Earth and the stars, the roll search rate and the time Earth was "seen," the star then acquired by the Canopus sensor can be identified.

During firing of the midcourse motor, stabilization of the spacecraft will be effected by the use of four rudder-like jet vanes mounted in the downstream end of the engine nozzle. The Mariner's autopilot controls spacecraft attitude during engine firing by using the three gyros to sense motion about the spacecraft's three axes for positioning the jet vanes. Each vane has its own separate control system and, because the midcourse motor is not mounted along any of the three axes, each is activated by a mixture of signals from the three gyros. Constant adjustment of the angles of the jet vanes ensures that the motor thrust direction remains through the spacecraft's center of gravity.

Two more sensors round out the attitude control system. The planet sensor is used for on-board initiation of the encounter phase of the mission. As the lighted limb of Venus appears in the sensor's field of view, a signal is transmitted to the data automation system to initiate the planetary science recording sequence. The terminator sensor changes the pointing direction of the high-gain antenna. As the spacecraft passes from the dark to the sunlit portion of the planet and light reflected from the day side enters the sensor's field of view, a signal is generated to effect a mechanical change in the antenna pointing angle.

Central Computer And Sequencer

The central computer and sequencer (CC&S) performs the timing, sequencing and computations for other subsystems aboard the Mariner spacecraft. The CC&S initiates spacecraft events in three different mission sequences -- launch, midcourse and cruise/encounter.

The launch sequence includes spacecraft events from launch until the cruise mode is established, a maximum of 16 2/3 hours after liftoff. These events include deployment of solar panels and activation of the attitude control subsystem and Canopus sensor.

The midcourse maneuver sequence controls the events necessary to perform the midcourse maneuver in trajectory. Three of these are commands radioed from Earth and stored in the CC&S prior to initiation of the maneuver. They tell the spacecraft how far and in which direction to turn on its pitch and roll axes and how long the midcourse rocket engine must fire.

The master timer sequence controls those events that occur during the cruising portion of flight and planet encounter. CC&S commands during this sequence switch the spacecraft telemetry transmission to a slower bit rate; switch the transmitter to the high-gain antenna; periodically set the Canopus sensor at various cone angles; turn on tape recorder power and enable the data automation system to begin the Venus encounter sequence; and switch to the post-encounter telemetry mode for transmission of recorded data.

The central computer and sequencer weighs about 11½ pounds.

Temperature Control

For a spacecraft traveling to Venus, away from Earth and toward the Sun, the primary temperature control problem is maintaining temperatures within allowable limits despite the increasing solar intensity as the mission progresses. In airless space, the temperature differential between the sunlit side and the shaded side of an object can be several hundred degrees.

Heating by direct sunlight on the Mariner spacecraft is minimized by the use of thermal blankets, a deployable sunshade and the placement of solar panels as far as possible from the spacecraft's octagonal body.

The thermal blankets insulating the octagon -- top and bottom -- are sandwich assemblies of multiple layers of aluminized Teflon and Mylar to reflect heat from the sunlit side of the spacecraft and, on the opposite side, to retain heat generated by power consumption within the spacecraft. Small thermal blankets shade the trapped radiation detector and the gas jet assemblies.

The deployable sunshade complements the sunside thermal shield by forming an octagonal awning which extends about 10 inches beyond the periphery of the spacecraft structure. During launch, the shade -- consisting of a single sheet of aluminized Teflon stretched on a lightweight frame -- is in a retracted position. It is deployed to its extended position at the time of solar panel deployment. The shade protects units extending beyond the octagon.

Temperature control of six of the electronics compartments is provided by polished metal louvers actuated by coiled bimetallic strips. The strips act as spiral-wound springs that expand and contract as they heat and cool. This mechanical action, which opens and closes the louvers, is calibrated to provide an operating range from fully closed at 50° F. to fully open at 90° F. A louver assembly consists of 22 horizontal louvers driven in pairs by 11 actuators. Each pair operates independently on its own local temperature determined by internal power dissipation.

Paint patterns and polished metal surfaces are used on the Mariner for passive control of temperatures outside of the protected octagon. These surfaces control both the amount of heat dissipated into space and the amount of solar heat absorbed or reflected away, allowing the establishment of temperature limits. The patterns were determined from testing a Temperature Control Model (TCM) of the spacecraft and the flight spacecraft. The TCM was subjected to the variations of temperature greater than those anticipated in the Venus mission in a space simulation chamber at JPL.

Mounted at the outboard ends of three solar panels are temperature control reference (TCR) assemblies which, through the telemetry subsystem, will provide means of comparing preflight estimates of the effects of solar heating on the spacecraft with those actually encountered in flight. The TCRs also will verify laboratory-derived data on the thermal optical properties of painted spacecraft temperature control surfaces. The units are identical with the exception of the paint used on each as a temperature control surface and the thermometers monitoring the temperatures of the assemblies. Each TCR is a key-shaped plastic fin coated with the appropriate paint and bonded to a metal bracket for attachment to the tips of the panels.

SCIENTIFIC INVESTIGATIONS

Despite its closeness to Earth and the measurements of Mariner II and Earth telescopes, Venus remains one of the most mysterious planets in the solar system.

It is similar to Earth in mass, density and size but it is enshrouded with clouds and no one has ever seen its surface.

Because Venus is closer to the Sun than the Earth, some theories of planetary atmospheres lead to the conclusion that its atmosphere should be thinner than the Earth's. Yet most of the evidence indicates a very dense atmosphere, variously estimated at from five to several hundred times as dense as the Earth's atmosphere.

Spectroscopic studies have indicated the presence of carbon-dioxide and water vapor in very small amounts but the composition of the Venusian atmosphere remains 99 per cent unknown.

The scientific investigations to be conducted on the 1967 Venus mission are designed to produce additional information on the structure of the planet's atmosphere and on its radiation and magnetic environment.

The 67 Mariner will pass within some 2,000 miles of the surface of Venus (compared with 21,600 miles for Mariner II) and on the side of the planet favorable for detecting its magnetic wake.

The Mariner Venus 67 experiments are ultraviolet photometry, S-band occultation, dual-frequency radio occultation, trapped radiation detection, magnetic field measurements, solar wind measurements, and celestial mechanics.

The ultraviolet photometry experiment is designed to measure atomic hydrogen and atomic oxygen in the upper atmosphere from which atmospheric scale height and a temperature profile of the upper atmosphere can be calculated.

The radio occultation experiments should provide data on the refractivity profile of the atmosphere. Temperatures, pressures and densities can then be deduced by assuming model atmospheres composed of various constituents.

The magnetic field measurements are designed to determine the direction and strength of any magnetic field that may exist around Venus as well as provide data on the interplanetary magnetic field.

The trapped radiation experiment will observe charged particles of various energies during interplanetary cruise and around Venus.

The solar wind experiment will study the density, velocities and direction of the relatively low energy particles of the solar wind and their possible interaction with Venus.

The celestial mechanics experiment will use tracking data to further refine our knowledge of the astronomical unit and the mass and ephemeris of Venus.

The three experiments primarily designed for atmospheric studies (ultraviolet photometry and the two occultation experiments) are being flown to Venus for the first time.

Information from five of the experiments will be processed onboard the spacecraft by the data automation system into digital form suitable for radio transmission to Earth.

Data Automation System

The experiments controlled by the data automation system (DAS) are the ultraviolet photometer, dual-frequency radio propagation, trapped radiation detector, helium magnetometer and the solar plasma probe. The S-band occultation experiment and the celestial mechanics experiment do not require special equipment aboard the spacecraft and are not contolled by the DAS.

During the mission, the DAS accumulates scientific data from each of the five experiments, reduces the data from each experiment to a common digital form and common rate and then feeds the data to the radio transmitter telemetry channel at proper intervals.

The telemetry channel alternately carries 280 bits of scientific data and 140 bits of engineering data in the cruise phase. During Venus encounter the 140 bits are used for additional science data, information on performance of the scientific instruments and a small fraction for engineering purposes necessary to maintain ground command capability.

Data from the interplanetary instruments are transmitted as soon as received and conditioned by the DAS. During encounter all science data are recorded on the tape. However, data compatible to the telemetry transmission rate of 8 1/3 bits per second will also be transmitted as real-time.

The DAS is composed of four units: real-time unit, non-real-time unit, buffer memory and power converter. The total weight is about 20 pounds.

S-band Occultation Experiment

The purpose of the S-band occultation experiment is to determine the density of the Venusian atomsphere by transmitting radio signals from the spacecraft through the atmosphere of Venus to Earth. To accomplish this requires accurate control of the trajectory of the spacecraft as it passes the planet.

The experiment does not require special equipment on the spacecraft but relies on the signal used to transmit telemetry data to Earth.

As the spacecraft curves behind Venus, the radio waves will be deflected into a curved path by the atmosphere and will change in frequency and strength. Bending due to refraction of the waves will occur in the atmosphere in a manner similar to light waves being bent by water. This effect is measured in the frequency shift of the carrier wave. The reduction in strength of the signal is caused by unequal bending, or defocusing, in the atmosphere.

A successful experiment will chart the density profile of the atmosphere, that is, the rate at which the atmosphere increases in density from the top of the atmosphere down to ground level.

However, because of the expected high density of the Venusian atmosphere, there are several uncertainties associated with this experiment. Optical, infrared and radio observations from Earth place values on the Venusian atmosphere that range from five times the density of Earth's atmosphere to several hundred times.

It is estimated that if the density is too great the radio signal from the spacecraft may be trapped into a spiral path about the planet and never reached Earth. In this case, the density profile will be obtained only done to some limiting altitude above the surface.

Even at lesser densities it is possible that the rapidly increasing density of the Venusian atmosphere from high altitudes downward may cause a rapid shift in the frequency of the received signal. Earth tracking stations are specially configured to accommodate such a shift in frequency to enable data acquisition during these periods. However, if frequency deviations exceed these capabilities, data may not be acquired when frequency is shifting at a very high rate.

The expected bending of the signal by the atmosphere will be countered by pointing the antenna initially in the direction opposite to that of the expected bending, as a rifleman will aim slightly off target to allow for the effect of wind on the bullet's flightpath. Before the spacecraft emerges from behind Venus, the antenna will be automatically shifted by about eighteen degrees in the opposite direction to counter the bending by the atmosphere on the other side of the planet.

Determination of the density of the Venusian atmosphere is an important factor in the design of planetary landers in future Venus missions, and is a critical factor in the resolution of important scientific questions on the nature of the atmosphere.

Investigators are Dr. A. J. Kliore, Jet Propulsion Laboratory; D. L. Cain, Jet Propulsion Laboratory; Dr. G. Fjeldbo, Stanford University; Dr. S. I. Rasool, Goddard Institute for Space Studies; G. S. Levy, Jet Propulsion Laboratory.

Dual Frequency Propagation Experiment

The dual frequency propagation experiment will measure electrons in the ionosphere of Venus and in space during the flight from Earth to the (interplanetary magnetic fields. Measurements from the spacecraft can also be correlated with measurements of interplanetary magnetic storms made by other spacecraft.)

Electrons in the path of the radio signal will cause measureable dispersion effects in frequency and phase. In this experiment two harmonically-related frequencies, (423.3 Mc and 49.8 Mc) will be transmitted to the spacecraft from the 150-ft antenna of the Stanford Center for Radar Astronomy. The high frequency will be less affected by the electrons in the path of the signal than the low frequency. The dual frequency receiver aboard the spacecraft will compare the phase shifts between the two signals, thus measuring the total number of electrons encountered by the signal.

During the fly-by of Venus the experiment will measure electron density in the upper atmosphere as a function of height. The results will provide new information on the structure of the Venus ionosphere. The measurements will be made on both the day and night sides of Venus during the occultation.

The dual receiver weighs approximately six pounds and draws less than two watts of power. A high frequency antenna is mounted at the end of one solar panel and two panels are utilized as antennas for the low frequency.

The experimenters are: Dr. V. R. Eshleman, Stanford University; Dr. G. Fjeldbo, Stanford University; Dr. H. T. Howard, Stanford University; R. L. Leadabrand, Stanford Research Center Institute; R. A. Long, Stanford Research Center Institute; B. B. Lusignan, Stanford University.

Solar Plasma Probe

The solar plasma probe will measure the density, velocity, temperature and direction of low energy (45 electron volts to 9,400 electron volts) protons that stream outward from the Sun at supersonic speeds to form what has been termed the solar wind.

Solar plasma emitted from the Sun is a boiling off of the Sun's atmosphere. It is a thin, high-velocity, high-temperature gas. It is composed of the same material as the Sun, nuclei of helium and hydrogen atoms, with hydrogen nuclei (protons) being predominant, and enough electrons to make the gas electrically neutral. The atoms in the solar plasma are ionized (separated from their electrons) because of the very high temperature of the outer atmosphere (corona) of the Sun.

Earlier solar plasma experiments in space, on Mariners, Explorers, Pioneers, and other spacecraft, have provided data on the solar wind. However, the changing characteristics of the solar plasma are related to a cycle of solar activity that spans 11 years. Only a small fraction of the desired information has been obtained.

The solar plasma probe is composed of charged particle voltage filters which allow detection of protons at 32 energy bands within a range of 45 to 9,400 electron volts. From the measurement of current collection in each of the 32 energy ranges, the density, velocity, and temperature of the plasma can be deduced.

The direction of motion is obtained by dividing the collector into three pie-shaped sectors. If the solar plasma enters the probe and impinges on the current collecting plates at an angle, the sectors will not receive equal currents, and the direction of the plasma's motion can be inferred from the current ratios on the three sectors.

The plasma probe is mounted on the bottom of the spacecraft bus, pointed directly at the Sun. It weighs seven pounds and utilized three watts of power.

The investigators for the plasma probe are Dr. Herbert L. Bridge and Dr. Alan Lazarus of the Massachusetts Institute of Technology and Dr. Conway W. Snyder of the Jet Propulsion Laboratory.

Trapped Radiation Detector

The purposes of this experiment are to search for magnetically trapped radiation in the vicinity of Venus (if it exists, it might be similar to the Earth's Van Allen belts of trapped radiation);measure distribution and energy levels of cosmic rays and electrons in interplanetary space with special reference to energetic particles emitted from the Sun; and search for particle effects in the solar wake of Venus.

The experiment consists of four detectors, three Geiger-Mueller tubes and one solid state detector, a silicon diode covered with thin nickel foil to exclude light.

The three Geiger-Mueller tubes are shielded so that low energy particles can only enter by passing through a window at the end of each tube. Tubes A and B will detect protons greater than 500 thousand electron volts and electrons greater than 40 thousand electron volts. Tube C will detect protons greater than 900 thousand electron volts and electrons greater than 70 thousand electron volts. The solid state detector will measure flux and energy of protons in three energy ranges varying from 250 thousand electron volts to two million electron volts, and alpha particles in four energy ranges varying from 400 thousand electron volts to 200 million electron volts. One Geiger-Mueller tube points directly toward the Sun and will also count solar X-rays.

The experiment is located on the top of the spacecraft bus and weighs about $2\frac{1}{4}$ pounds.

Investigators are Dr. James A. Van Allen, Dr. Louis A. Frank, and Stamatois M. Krimigis of the University of Iowa.

Helium Magnetometer

The scientific objectives of the magnetometer experiment are to determine if Venus has a magnetic field and, if so, to map its characteristics; to investigate the interaction between the planet and the solar wind, and to measure the magnitude and direction of the interplanetary magnetic field and determine its variations.

It is known from the Mariner II measurements in 1962 that the magnetic field around Venus is much weaker than Earth's, but even if Venus were completely nonmagnetic, the solar plasma flowing around the planet and its atmosphere would produce a wake or tail similar to, but smaller than, the Earth's magnetosphere. Mariner 67 will fly through this tail, and the disturbance of the magnetic fields embedded in the solar wind are expected to be detectable by the magnetometer.

The magnetometer may detect a general magnetic field around Venus if such a field exists and if the spacecraft trajectory penetrates far enough into the cavity formed by the solar wind around the planet. In this area a planetary field is relatively undisturbed by the solar wind.

Knowledge of the interplanetary field is important in understanding the nature of solar cosmic rays, solar flares, galactic cosmic rays, origin of the solar wind near the Sun, solar magnetic fields and the interaction of the solar wind with the Earth and Moon.

The magnetometer is a low field vector magnetometer that measures the magnitude of the magnetic field and its direction.

A helium magnetometer is based on the principle that the amount of polarized light that can pass through helium gas, that has been excited to a higher than normal energy level, is dependent on the angle between the light axis and the direction of the surrounding magnetic field. Measuring the amount of light passed through the helium gives a measurement of the magnetic field in magnitude and direction.

The light source is a helium lamp in the magnetometer. The light, collimated and circularly polarized, passes through a cell containing the excited helium gas and then impinges on an infrared detector that measures the amount of light passed through the helium gas.

The magnetometer sensor is located on the low-gain antenna mast to minimize the effect of the spacecraft's magnetic fields. Electronics supporting the experiments are located in a compartment on the spacecraft. The sensor weighs 1.25 pounds. The electronics weigh six pounds. It is sensitive to fields of less than one-half gamma per axis and the dynamic range is $\pm$ 360 gamma per axis. The experiment operates on seven watts of power.

The investigators are Dr. Edward J. Smith, JPL; Dr. Paul J. Coleman, Jr., University of California at Los Angeles; Prof. Leverett Davis, Jr., California Institute of Technology; and Dr. Douglas E. Jones, Brigham Young University and JPL.

Ultraviolet Photometer

Measurements of the upper atmosphere (exosphere) of Venus should reveal the density and temperature of two components, atomic hydrogen and atomic oxygen, expected to be present. The data, combined with information acquired from Earth or by other spacecraft experiments, will provide a better understanding of the Venusian atmosphere. It is possible that the high altitude measurements of the two elements may yield information on the composition, now unknown, at the lower altitudes.

Detection and accurate measurement of the two elements is made possible by the layered structure of planetary exospheres due to the planet's gravitational field. The layers are arranged according to the atomic weight of the components with hydrogen, the lightest, at top followed by helium, then oxygen.

The atoms of hydrogen and oxygen in a planet's upper atmosphere are excited by solar energy and emit energy in the ultraviolet range. The photometers will measure the amount of this radiation. From these data the total atomic abundance of the two elements in the Venusian atmosphere can be calculated.

From the variation in light intensity observed as the photometer sweeps across the planet, the scale height of hydrogen and oxygen can also be deduced. Defined as the change in altitude required to change the density by the factor 2.8, the scale height is a direct measure of the temperature at various levels of the upper atmosphere.

The experiment consists of three photomultiplier tubes, amplifiers, high-voltage controls, high-voltage power supplies, logic circuitry, and a power module. The total weight is approximately eight pounds.

The sensor tubes are three identical eighteen-stage photomultiplier tubes with cesium iodide photocathodes and lithium fluoride windows, but their sensitivities are different because of different optical filters mounted ahead of the tubes. The wave length sensitivity of the phototubes with the following filters are: Tube A, calcium fluoride filter, 1,250 to 1,900 A°; Tube B, barium fluoride filter, 1,350 to 1,900 A°; Tube C, lithium fluoride filter, 1,050 to 1,900 A°. The atomic hydrogen density measurement is proportional to the intensity difference between tubes C and A. The atomic oxygen density measurement is proportional to the intensity difference between tubes A and B.

The experimenters are: Dr. C. A. Barth, University of Colorado; Dr. W. G. Fastie, Johns Hopkins University; K. K. Kelly, University of Colorado; E. Mackey, Packard Bell; J. B. Pearce, University of Colorado; Dr. L. Wallace, Kitt Peak Observatory.

Celestial Mechanics Experiment

The purpose of this experiment is to refine basic information on the masses of Venus and the Moon, the astronomical unit (AU) and the ephemerides of the Earth and Venus. The tracking data from the 1967 Mariner probe can provide such information and as a consequence make a significant contribution to the fields of celestial mechanics and astrodynamics and for future projects requiring accurate navigation.

There are several factors in the Mariner 1967 mission that enhance the value of this experiment. The trajectory is close enough to the planet that the planetary mass will have a pronounced effect on the flight path causing the spacecraft to curve around the planet. Analysis of tracking data from the encounter portion of the flight then should yield new values for the planet's mass, the AU and the position of Venus relative to the Sun during the encounter period. In addition, tracking stations of the Deep Space Net are equipped with atomic standards to control transmitter frequency providing a required accuracy for this experiment and to record observation times. Other improvements in the technology of orbit determination will also enhance the results of the experiment.

Interpretation of the data from this experiment will lean heavily on correlation with data from the Mariner II Venus flight in 1962, radar bounce data obtained from Earth, optical observations and the existing body of scientific knowledge.

The experimenters are Dr. J. D. Anderson, Dr. L. Efron, G. E. Pease, and Dr. R. C. Tausworthe, all of the Jet Propulsion Laboratory.

ATLAS-AGENA D LAUNCH VEHICLE

The Mariner Venus 67 launch vehicle and associated equipment is all flight-proven hardware. NASA has flown the Atlas SLV-3/Agena-D combination on Applications Technology Satellite and Lunar Orbiter missions. The spacecraft adapter is the same as that successfully flown on Mariner IV. The metal aerodynamic shroud used for Lunar Orbiter has been modified to meet the needs of Mariner Venus 67. These modifications included: providing a nitrogen purge gas fitting, installing a spacecraft umbilical door and omitting the air conditioning door use for Orbiter.

On-pad spacecraft cooling, a responsibility of the launch vehicle manager, has definite limits in the Mariner Venus 67 mission. The bulk gas temperature within the shrouds must be kept between 40 and 50 degrees F. from the time of gantry removal to launch. A cooling blanket designed to meet this requirement was also used on Mariner IV.

Since a Venus launch opportunity occurs only once every 19 months, a great deal of contingency planning was required to insure that the spacecraft can be launched in this period. In addition to supplying an unusually large number of space vehicle parts at Cape Kennedy, available emergency measures include:

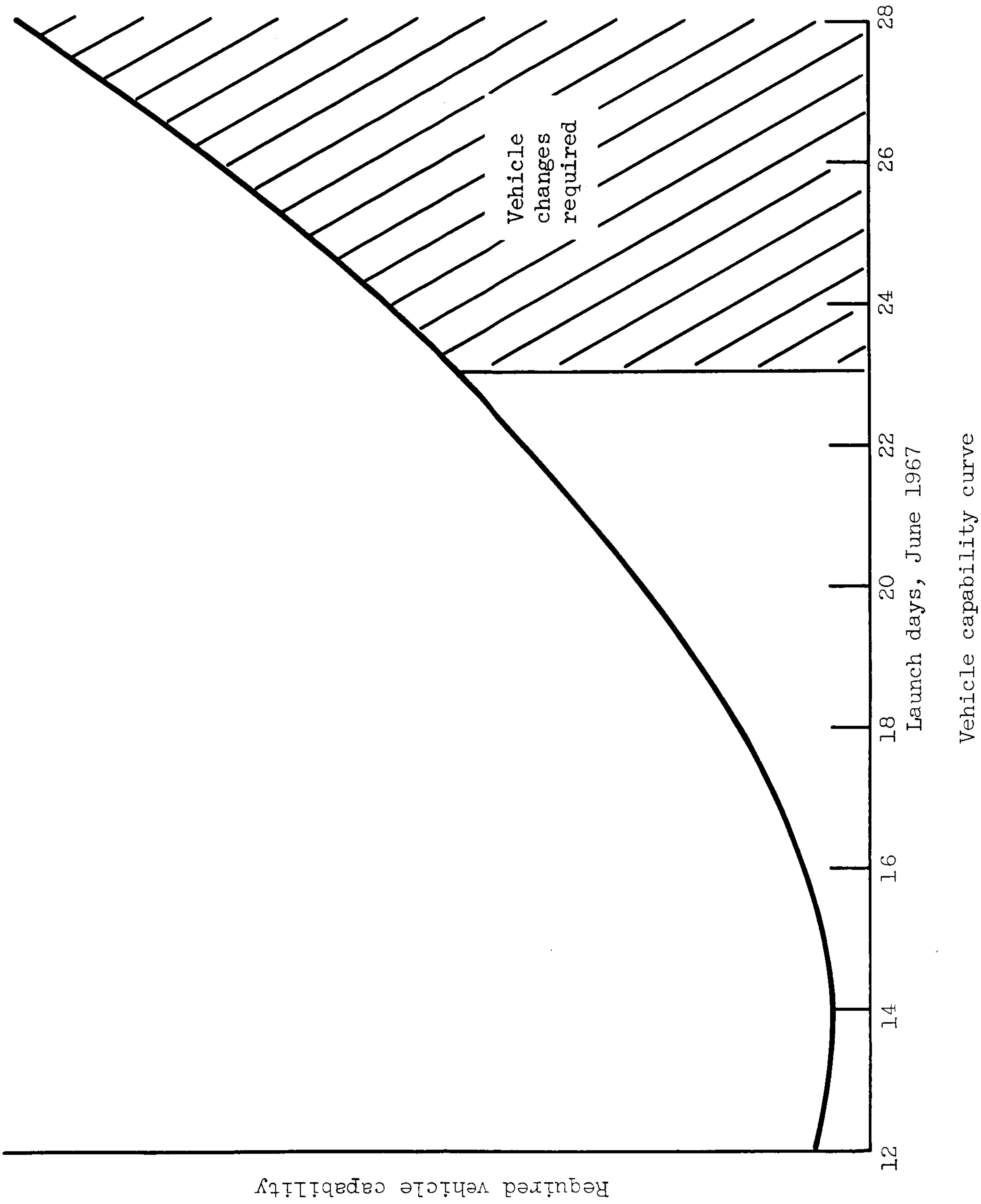
- a complete extra shroud and adapter will be checked out and ready for emergency use if required; and

- emergency provisions have been made to reduce Agena vehicle weight and thereby increase the number of possible launch days.

Like any other planetary launch, the job of the Atlas-Agena D launch vehicle is to thread Mariner through a specific spot above the atmosphere at a specific speed. If this is accomplished, the spacecraft will then have enough energy to carry it along the desired path to Venus.

The mission plan dictates Venus encounter at a particular date and time. Therefore, the later the launch, the shorter the trip time. As the trip becomes shorter and faster, the launch vehicle job becomes more difficult as illustrated in the Vehicle Capability Curve.

The launch vehicle requirements begin to change more and more radically with each successive day toward the end of the launch opportunity. In the cross-hatched area the Agena must be changed to achieve the required vehicle capability. This means removing about 10 pounds for each day beyond June 23.


Vehicle changes required
12
14
16
18
20
22
24
26
28
Launch days, June 1967
Vehicle capability curve
Required vehicle capability

Launch Vehicle Events

The sequencing of launch vehicle events is controlled by the actual position and velocity of the vehicle rather than by a pre-programmed time. However, the following are representative times of launch vehicle events such as they might occur on an actual mission.

Event	Plus Time (seconds)	Miles Downrange	Miles Altitude	Velocity (mph)
BECO	129	49	32	6,536
Booster Jettison	131	54	34	6,613
SECO	297	420	94	12,905
VECO	317	485	100	12,891
Shroud Jettison	320	493	101	12,887
Atlas/Agena Separation	322	499	107	12,884
Agena First Burn	374	664	111	12,825
Agena First Burn Cutoff	517	1,200	115	17,437
Agena Second Burn Start	1,484	4,285	114.6	17,441
Agena Second Burn Cutoff	1,580	4,798	121	25,466
Spacecraft Injection	1,740		241	

The duration of Agena first burn is slightly more than two minutes. The exact duration is dependent on the day and hour of launch. Second burn, which takes place over the Southern Pacific, is slightly more than one and one-half minutes, similarly varying with launch time.

To avoid any possibility of contaminating Venus, the probability of Agena hitting the planet must be kept to less than one to 10,000. This requires a posigrade rather than the usual retrograde maneuver. That is, after spacecraft separation, the Agena yaws slightly and the posigrade rocket fire sends the vehicle ahead of the Mariner on a non-collision course. Agena's closest approach to Venus with this maneuver should be about 2,485 miles.

Launch Vehicle Statistics

Total Height (Mariner-Agena-Atlas) 105 feet

Total Weight (Mariner-Agena-Atlas) 279,000 pounds

	Atlas	Agena D
Height	68 feet	23 feet
Weight	261,000 pounds	15,600 pounds
Diameter	10 feet	5 feet
Propellants	RP-1 fuel (11,530 gallons) LOX (8,530 gallons)	Unsymmetrical dimethyl hydrazine UDMH (585 gallons) and inhibited red fuming nitric acid IRFNA (745 gallons)
Thrust	388,000 pounds at liftoff	16,000 pounds at altitude
Propulsion	2 Rocketdyne boosters, 1 sustainer, and 2 verniers	Bell Aerosystems Engine
Guidance	G.E. Mod III	Lockheed inertial reference package
Prime Contractor	General Dynamics/ Convair, San Diego, Calif.	Lockheed Missiles & Space Co., Sunnyvale, Calif.

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TRACKING AND DATA ACQUISITION SYSTEM

The Jet Propulsion Laboratory has been assigned by NASA the responsibility for assuring the operation of ground-based facilities to support the Mariner Venus 67 tracking and data acquisition requirements. These requirements cover launch vehicle and spacecraft telemetry; metric data involving the tracking of the launch vehicle by C-band radars and the Mariner at S-band frequencies; sending of commands to the spacecraft; and real-time transmission of some of these data to the Space Flight Operations Facility (SFOF) at JPL in Pasadena.

The near-Earth trajectory requirements are met by selected facilities of the Air Force Eastern Test Range during launch phase, communications ships on the Atlantic, and NASA's Goddard Space Flight Center network of tracking and communications facilities. Trajectory of the spacecraft from injection into the Venus orbit until the end of the mission will be supported by the Deep Space Network (DSN).

The DSN consists of space communications stations on four continents and on a South Atlantic island; a spacecraft monitoring station at Cape Kennedy; the Space Flight Operations Facility at JPL; and a ground communications system linking all locations.

Permanent stations, placed at approximately 120-degree intervals around the Earth, include the Goldstone Space Communications Complex in the Mojave Desert, Calif.; two sites in Australia, at Woomera and at Tidbinbilla near Canberra; the Robledo and Cebreros facilities near Madrid, Spain; and stations at Johannesburg, South Africa; and on Ascension Island. Each is equipped with an 85-foot-diameter parabolic antenna, with the exception of the Mars Station at Goldstone (210-foot antenna) and Ascension Island (30-foot antenna). The spacecraft monitoring station at Cape Kennedy is equipped with a four-foot antenna.

The DSN is under the technical direction of JPL for NASA's Office of Tracking and Data Acquisition. Its mission is to provide tracking data (spacecraft velocity and position with respect to Earth), and to receive telemetry from and send commands to unmanned lunar and planetary spacecraft from the time they are injected into orbit until they complete their missions.

The ground communications system, used by the DSN for operational control and data transmission between the stations and the SFOF at JPL, is part of a larger network, NASCOM, which links all of NASA's stations around the world. NASCOM is under the technical direction of the Goddard Space Flight Center, Greenbelt, Md.

The Goldstone DSN stations are operated by JPL with the assistance of the Bendix Field Engineering Corp.

The Woomera and Tidbinbilla stations are operated by the Australian Department of Supply.

The Johannesburg station is operated by the South African government through the National Institute for Telecommunications Research.

At Madrid, JPL operates the two facilities under an agreement with the Spanish government in conjunction with the Instituto Nacional de Tecnica Aeroespacial (INTA), and with support from the Bendix Field Engineering Corp.

The 1967 Mariner mission to Venus will span a time period of about four to five months. The Deep Space Network is capable of monitoring the Mariner spacecraft continuously. The permanent stations provide 360 degrees coverage around the Earth so that one or more of their antennas will always point toward the spacecraft.

Nerve center of the network is the Space Flight Operations Facility at JPL. The overseas stations and Goldstone are linked to the SFOF by a communications network, allowing tracking and telemetry information to be sent there for analysis.

In addition to the giant antennas, each of the stations of the DSN is equipped with transmitting, receiving, data handling, and interstation communication equipment. Microwave frequencies (S-band) will be used in all communications with the Mariner spacecraft.

The Pioneer station at Goldstone, along with Tidbinbilla in Australia and Robledo in Spain, will be primary stations for the Mariner Venus 67 mission. Each has a 10,000 watt transmitter. The Mars station at Goldstone, with its 210-foot antenna and 20,000 watt transmitter also will be used during the mission, particularly for monitoring the Mariner spacecraft during planet fly-by. The Ascension Island station will track the spacecraft during the launch phase.

Metric data obtained immediately after liftoff and through the near-Earth phase will be computed at both the Real-Time Computer Facility, Air Force Eastern Test Range, Cape Kennedy, and the Central Computing Facility in the SFOF so that accurate predictions can be sent to the DSN stations giving the locations of Mariner in the sky when it appears on the horizon.

Scientific and engineering measurements radioed from the spacecraft are received at one of the stations, recorded on tape and simultaneously transmitted to the SFOF via high speed data lines, teletype or microwave radio.

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Incoming information is again recorded on magnetic tape and entered into the SFOF's computer system for processing.

Scientists and engineers seated at consoles in the SFOF have push-button control of the displayed information they require either on TV screens in the consoles or on projection screens and automatic plotters and printers. The processed information also is stored in the computer system disc file and is available on command.

The major command center, designed for 24-hour-a-day functioning and equipped to handle two spaceflight missions concurrently while monitoring a third, is manned by some 250 personnel of JPL and Bendix Field Engineering Corp. during critical events -- launch, midcourse maneuver, planet encounter -- of a Mariner mission.

In the SFOF's Mission Support Area (MSA), monitoring consoles are set up for the project manager, operations director in charge of the mission, operations manager responsible for physical operation of the SFOF and for representatives from three supporting technical teams -- Space Science Analysis, Flight Path Analysis and Spacecraft Performance Analysis.

Space Science Analysis is responsible for evaluation of data from the scientific experiments aboard the spacecraft and for generation of commands controlling the experiments.

Flight Path Analysis is responsible for evaluation of tracking data, determination of flight path and generation of commands affecting the trajectory of the spacecraft.

Spacecraft Performance Analysis evaluates the condition of the spacecraft from engineering data radioed to Earth and generates commands to the spacecraft affecting its performance.

The DSN currently supports, in addition to Mariner Venus, the continued tracking of Mariner IV (Earth to Mars 1964-65) and the missions of the Surveyor, Lunar Orbiter and Pioneer projects. Future projects include Mariner Mars 1969 and 1971, Voyager and backup for the Apollo manned lunar missions.

TRAJECTORY

Mariner Venus 67 will be launched from Cape Kennedy at a sufficient velocity to escape Earth plus the additional velocity, in the opposite direction of the Earth's motion, required to slow the spacecraft enough so that it will be pulled in by the Sun to provide an encounter with Venus.

Escape velocity, 25,200 miles per hour, would only be sufficient to place a Mariner in a solar orbit that would be near Earth's orbit. The additional velocity, countering a portion of Earth's velocity of 66,000 miles per hour, is carefully calculated to yield a solar orbit that will cross the path of Venus when Venus will be at a given location on Oct. 19, 1967. On that arrival date the spacecraft will be properly oriented to Venus, Earth, and Sun to perform its scientific experiments, to communicate with Earth and to receive power from the Sun.

The required velocity is imparted to the spacecraft at the point of injection by the second burn of the Agena-D second stage motors. This final velocity, and the injection point, varies from day to day throughout the launch period. Even though the arrival time and location of Venus remains constant, the motion of the Earth in its solar orbit changes the injection requirements.

A typical injection velocity is 25,515 miles per hour, relative to Earth. At encounter the spacecraft will be flying past the surface of Venus at an estimated 18,440 miles per hour relative to Venus. Velocities can only be stated in the relative sense because a body moving within our solar system will be seen moving with different velocities to two observers in different locations.

To an observer on Earth, the velocity of Mariner at injection would be as stated, 25,515 mph. To an observer on the Sun, the velocity of the spacecraft at injection would be 72,255 mph. This is because the Earth itself is orbiting the Sun at a speed of approximately 66,000 mph. This velocity plus the injection velocity is imparted to the spacecraft at injection. However, these two quantities are added vectorially, or in different directions. Only if the two were in the same direction would the total be 91,515 miles per hour.

For approximately nine days after injection, the Earth's gravitational attraction will slow the spacecraft. After the spacecraft has flown far enough from Earth (about 1,550,000 miles) so that it is no longer being slowed down by the Earth's pull, its original velocity relative to the Earth of 25,515 mph will have been reduced to 6,740 mph.

The speed of Mariner relative to the Sun is now 60,879 mph which is less than the Earth's speed relative to the Sun. In this sense, Mariner has used up most of its initial 25,515 mph to escape Earth and the remaining 6,740 mph has been used to slow itself down from the original speed that it had due to the Earth's motion of 66,000 mph. The present velocity of 60,879 mph will allow the spacecraft to orbit the Sun closer than Earth and curve inward toward Venus.

At launch Venus will be trailing the Earth. At encounter, Venus will have moved ahead of the slower moving Earth by approximately 43,600,000 miles.

The spacecraft will follow a long curving path around the Sun after injection covering 212,500,000 miles before it encounters Venus. It will pass behind Venus at encounter, relative to the Earth, to allow the occultation experiment. It will be behind Venus for approximately 26 minutes.

Mariner's trajectory is planned to pass Venus ahead of its orbit around the Sun. The configuration desired for the Venus occultation experiments -- the requirement that the Sun always be visible to the spacecraft to provide power to the solar panels and that the spacecraft altitude reference star Canopus be always visible -- led to determining a fixed arrival geometry for the Sun, Venus, and Earth and hence a fixed arrival date, Oct. 19, 1967. This simplified the task of designing trajectories for the Venus mission.

The restrictions that the trajectory engineer must keep in mind in designing a suitable trajectory include, for example, that the flight time must not exceed certain limits imposed by the lifetime of the spacecraft; injection velocities are bounded by the capability of the boost vehicle, thus affecting the flight time; the Sun must not be occulted from the spacecraft; the star Canopus must not be occulted from the spacecraft nor can light from the planet's near limb be close enough to affect the Canopus sensor mechanism; and encounter must occur during the viewing period of the Goldstone station of the Deep Space Network. Encounter over Goldstone is desired to allow use of the new and highly sensitive 210-foot diameter antenna, the only 210 in the tracking network. Other factors influencing the trajectory include the effect of solar wind pressure on the flight path; the gravitational attraction of Sun, Earth, Mars, Mercury, Venus, and Jupiter; and a requirement that the encounter velocity be as low as possible.

In selecting an aiming point that will determine the path of the spacecraft as it passes Venus, the trajectory engineer must assure that the Mariner will not impact Venus, in order to prevent contamination of the planet by living Earth organisms. The aiming point must also satisfy the requirements of the scientific experiments aboard the spacecraft. It is desired that the point of closest approach at Venus will be 2,000 miles.

The accuracy of the encounter with Venus will be influenced by the launch accuracy and the midcourse maneuver accuracy.

Calculations after launch will determine if the flight path of the spacecraft is within the capability of the midcourse motor. Mariner has the capability of performing two midcourse maneuvers in the event the first does not yield the desired accuracy for encounter.

The accuracies demanded by the launch vehicle and by the midcourse motor can be illustrated by the following numbers. The injection velocity can vary only by 30 miles per hour or the resulting trajectory will not be within the correction capability of the midcourse motor. At midcourse maneuver, an error of one mile per hour in the velocity change will result in an error at Venus of 2,000 miles.

ATLAS-AGENA D/MARINER VENUS 67 MISSION

Each day during the launch opportunity there is a space of a few hours called the launch window. These times are the outer limits of when Mariner-Venus can be launched. The following launch windows will be further refined by pre-launch tracking and spacecraft considerations.

Date	Window Opens EDT	Window Closes EDT
June 12	1:16 a.m.	3:30 a.m.
June 13	12:59 a.m.	3:17 a.m.
June 14	12:44 a.m.	3:04 a.m.
June 15	12:29 a.m.	2:52 a.m.
June 16	12:15 a.m.	2:40 a.m.
June 17	12:01 a.m.	2:29 a.m.
June 17-18	11:48 p.m.	2:17 a.m.
June 18-19	11:34 p.m.	2:06 a.m.
June 19-20	11:22 p.m.	1:55 a.m.
June 20-21	11:09 p.m.	1:45 a.m.
June 21-22	10:57 p.m.	1:34 a.m.

Atlas Flight

Depending on the time of day, the flight azimuth from Launch Complex 12 at Cape Kennedy will vary between 90 and 114 degrees. All launch vehicle events vary with the day and hour of launch; however, the following flight plan is representative of a June 12 launch.

The Atlas engines gimbal to achieve the proper flight azimuth before the vehicle pitches over. This is accomplished between two and 15 seconds after liftoff.

Using position and velocity radar tracking data, the guidance computer determines the proper time for the Atlas booster engine to cutoff (BECO) and for staging. This occurs approximately two minutes after liftoff.

The sustainer and vernier engines burn for almost three minutes more until sustainer engine cutoff (SECO). After SECO, the two Atlas vernier engines provide final attitude positioning for Atlas/Agena separation.

An extremely important function of the radio guidance system is to start the Agena flight sequence timer at the correct point on the ascent trajectory. After Atlas/Agena separation, all Agena events except engine shutdown depend on this event timer. The guidance command signal to start Agena's timer occurs approximately five minutes into the Mariner Venus flight.

After vernier engine cutoff (VECO) the spacecraft shroud is jettisoned. Two seconds later the Agena and spacecraft separate from the now spent Atlas booster. Retrograde rockets back the Atlas away as Agena and the Mariner spacecraft draw free

Agena Flight

The first event for starting the Agena engine begins some six minutes after liftoff. Engine thrust is sensed by the onboard velocity meter. When the required velocity-to-be-gained (about 4,600 mph) has been reached, the velocity meter shuts down the Agena engine. This first burn should last approximately 135 seconds.

Agena/Mariner then coasts in a 115-mile-high circular parking orbit until reaching the correct point in space to restart and inject Mariner on its final trajectory to Venus. Again, the Agena velocity meter shuts down the engine when the required velocity-to-be-gained (about 8,000 mph) has been achieved. This second Agena burn lasts some 95 seconds.

At the proper time, the Mariner spacecraft is injected on a hyperbolic trajectory toward Venus. This Agena/Mariner separation occurs at an altitude of about 240 miles and a velocity of 25,466 mph with an allowable error of only some 57 mph.

First Spacecraft Events

Separation from the Agena, at 2.6 minutes after injection, trips a switch that initiates a series of spacecraft events:

- Full power is applied to the spacecraft transmitter. The transmitter has been held at low power until this point to prevent damaging high voltage arcing that can occur in a critical region between 150,000 to 250,000 feet altitude.

- The scientific experiments are turned on.

- The central computer and sequencer outputs are enabled.

- A turn-off command is sent to the tape recorder. The recorder is running during launch to keep tension on the tape to prevent unwinding and snarling of the tape from the vibration of launch.

- An inhibit is removed from the plasma probe experiment allowing application of 10,000 volts to the plasma sensor. The inhibit is applied to prevent high voltage arcing.

Separation also releases a pyrotechnic arming switch which turns on the attitude control system and fires explosive squibs, thus allowing the solar panels to be deployed.

A timing device is also activated by separation. The timer initiates a back-up command to arm the pyrotechnics and then commands solar panel deployment. The firing of squibs unlocks the four panels which are then deployed by springs. The sunshade on the sunward side of the spacecraft is also deployed by the unfolding of the solar panels.

The central computer and sequencer gives a backup command for panel deployment and for turn-on of the attitude control subsystem.

Sun and Canopus Acquisition

Sun acquisition is the next event and will be completed within approximately 20 minutes after deployment of the panels. Sun sensors, linked by logic circuitry to the attitude jets, will initiate commands to fire the jets in order to turn the spacecraft with the panels facing the Sun. Once the panels are illuminated by the Sun they begin converting solar energy to electrical energy to operate the spacecraft. Until this time power has been provided by a battery.

The next event is acquisition of Canopus, the brightest star in the Southern hemisphere. Locking the Canopus sensor on the star provides spacecraft stabilization about the roll axis. This event occurs about 16 hours after launch. The command to begin the roll search for Canopus is given by the central computer and sequencer. The spacecraft will roll slowly with the Canopus sensor reporting light intensities for each star that appears in its field of view. This data will be translated into a graph in the Space Flight Operations Facility in order to ascertain the location of Canopus in relation to the sensor. At the time the roll search begins the direction that the sensor is pointing will be uncertain.

The graph will provide a reference and assure that, when acquisition is complete, the sensor is locked on to Canopus and not some other star.

Midcourse Maneuver

Mariner will continue in this cruise attitude until the midcourse maneuver in which the flight path is corrected to eliminate aiming point bias,inherent launch errors and arrival time errors. Midcourse can be performed from two to 10 days after launch at the discretion of the project officials.

The commands for the timing of the pitch turn, roll turn and motor firing are transmitted from Earth and stored in the central computer and sequencer. Prior to initiating the turns an inhibit is removed from the propulsion system, the gyros are warmed up, and the required telemetry mode is commanded. Coincident with pitch-turn start the spacecraft is put on inertial control. The autopilot is turned on and the Canopus sensor turned off.

Analysis of the trajectory after launch will have provided the proper direction for pointing the midcourse motor to alter the trajectory and the required burn time for the motor. The spacecraft will perform a pitch turn, then a roll to point the motor properly. After motor burn the spacecraft will again automatically seek the Sun and Canopus. The trajectory of a spacecraft in space is determined by position and velocity. Altering the velocity will change the trajectory.

Subsequent tracking will determine if the desired new trajectory has been achieved. If not, a second midcourse maneuver can be performed.

Assuming the trajectory has been achieved, Mariner is again in the cruise attitude, it is transmitting scientific and engineering data to Earth at 33 1/3 bits per second and will continue in this fashion until the encounter sequence at Venus, with a few exceptions. As the spacecraft draws away from Earth it will be necessary to reduce the bit rate to 8 1/3 bits per second and at four times during the flight the direction in which the Canopus sensor looks will be adjusted to compensate for the changing angle between spacecraft and star. The adjustment is made electronically, the sensor is not moved.

Encounter Sequence

After approximately 3½ months of flight Mariner will be approaching Venus and the encounter sequence will begin. Defining encounter as the point of closest approach to the planet, the encounter sequence will be initiated at encounter minus 12 2/3 hours. The total time for the encounter sequence is 26 2/3 hours.

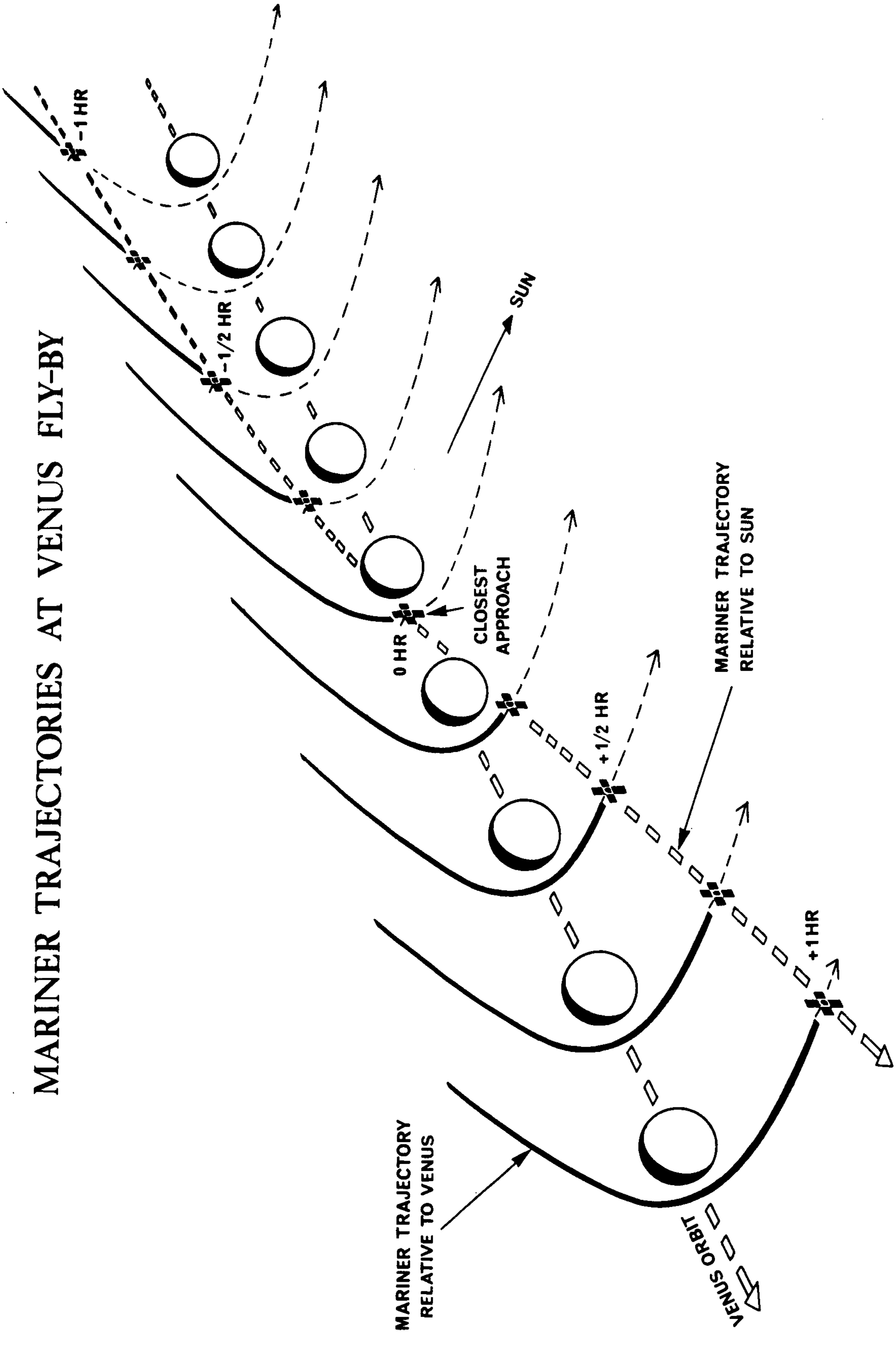
The first commands to prepare the spacecraft for encounter will be issued by the CC&S to turn on the tape recorder (power only, not recording), and turn on the terminator sensor.

The tape recorder will be used during the flyby for approximately two hours. High rate data from the dual frequency receiver experiment, the ultraviolet photometer and the trapped radiation detector as well as normal real-time data from all instruments will be recorded on track one through the data automation system. During the central 1½ hours of this period, data from the dual frequency experiment will be recorded on track two. Data will be recorded on each track at a rate of 66 2/3 bits per second. (The telemetry transmission rate from the spacecraft is only 8 1/3 bits per second at encounter necessitating data storage on tape.) The tape recorder has a storage capacity of one million bits.

The terminator sensor will be used during the occultation to detect the point in time when the spacecraft crosses the line between nighttime and daylight on Venus. Detection of the terminator will generate a signal to switch the antenna position to compensate for bending of the radio waves by the Venus atmosphere. This is required to permit reception of radio signals as the spacecraft emerges from behind the planet.

At six hours prior to point of closest approach the CC&S will order the data automation system (DAS) to switch to Data Mode 3 which eliminates transmission of engineering information allowing the entire format to be used for science data. This command is backed up by the transmission from Earth of a direct command. The planet sensor is also turned on at this point and the plasma probe is switched to the encounter mode.

At encounter minus approximately three hours a command is transmitted from Earth to activate Timer A in the DAS. Timer A, essentially a counter, will issue backup commands for critical events throughout encounter.



MARINER TRAJECTORIES AT VENUS FLY-BY

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Detection of the planet by the planet sensor will occur at approximately 60 minutes before closest approach, and will initiate commands ordering the ultraviolet photometer calibrate sequences to be inhibited, increase the sampling rate from the ultraviolet photometer, the trapped radiation detector and dual frequency receiver, start the recording of this data on track one and start Timer B in the DAS. Timer B will order tape recording of data from the dual frequency receiver 13.75 minutes later and Timer A will issue a backup to this command.

At encounter minus about five minutes, the spacecraft will enter the Earth occultation zone and, as seen from Earth, will disappear behind the planet. Eight minutes after closest approach the terminator sensor will initiate the command to change the antenna position. This command goes to the pyrotechnic subsystem. An explosive squib is fired allowing the antenna to switch. Timer A will issue a backup command to the pyrotechnic subsystem for this event.

Mariner will exit occultation and again be in view of Earth stations approximately 21 minutes after closest approach giving a total occultation time of an estimated 26 minutes. Earth tracking stations will lockup on the spacecraft transmitter as soon as possible after occultation in order to record additional data on the atmosphere from the experiments.

Approximately 50 minutes later the Timer B in the DAS stops sending dual frequency receiver data to track two of the tape recorder. Recording of track one data continues about nine minutes longer until the tape recorder is stopped automatically by an end-of-tape signal marking the end of the data storage sequence.

A few minutes later Timer B in that data automation system will switch the data encoder to Mode 2 (with a backup command from Earth), send a series of stop-tape commands as a backup to the end-of-tape signal, turn off the planet sensor and command the photometer and plasma probe back to the cruise mode. Timer A will issue a backup command for all these events.

Fourteen hours after encounter the spacecraft will be readied for the playback of the science data recorded during the flyby. The CC&S will issue a command to switch to data Mode 4 to start the playback. A backup command from Earth will also be sent. About 18 hours later the tape recorder will be commanded to switch tracks by an end-of-tape signal or by backup command from Earth.

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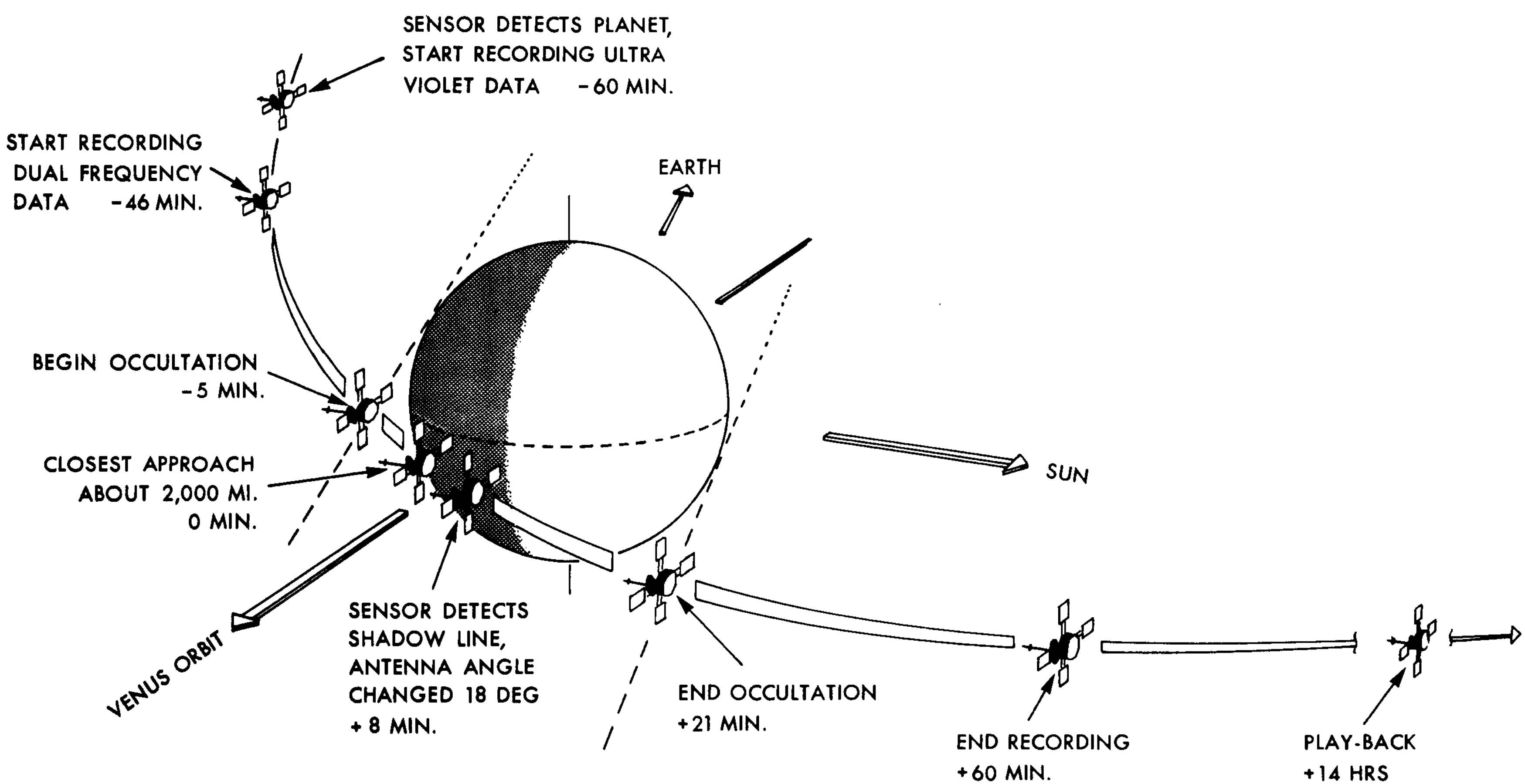
MARINER 1967 FLY-BY OF VENUS



The playback sequence consists of about 17 hours of science data from track one, two hours of real time engineering data from the spacecraft telemetry system and 14 more hours of recorded science data from track two. If track two is played back first, the timing is reversed. The real time sampling of engineering data between the readout of each of the tracks is required for Deep Space Network operational purposes and to provide information on the condition of systems aboard the spacecraft.

Additional playbacks of the recorded data are optional and can be controlled by ground commands.

Complete recovery of the stored data will satisfy the primary mission objective. An additional desired result is the reception of data as close to the Sun as possible as the spacecraft trajectory, altered by the mass of Venus, will carry the spacecraft nearer the Sun. This will be governed by the effect of increasing temperatures on the spacecraft. The point at which increasing temperature will affect the operation of the spacecraft is uncertain. The mission could also be terminated by the effect of the spacecraft's motion pointing the high gain antenna away from Earth.

MARINER VENUS 67 TEAM

The National Aeronautics and Space Administration's programs for unmanned investigation of space are directed by Dr. Homer E. Newell, Associate Administrator for Space Science and Applications (OSSA). His deputy is Edgar M. Cortright. Within OSSA, Oran W. Nicks is the Acting Director of the Lunar and Planetary Programs Division, and Glenn A. Reiff is the Mariner 67 Program Manager. Associated with Reiff are C. P. Wilson, Mariner program engineer; and Donald P. Easter, program scientist. Joseph B. Mahon is Agena Program Manager for OSSA's Launch Vehicle and Propulsion Programs.

NASA has assigned Mariner project management to the Jet Propulsion Laboratory, Pasadena, which is operated by the California Institute of Technology. Dr. William H. Pickering is the Director of JPL. Deputy Director of the Laboratory is A. R. Luedecke and Assistant Director Robert J. Parks heads JPL's lunar and planetary projects. Dr. Eberhardt Rechtin is Assistant Director for Tracking and Data Acquisition.

Dan Schneiderman is Mariner Project Manager. His assistant project manager is Theodore H. Parker. Project planning and control is under the direction of David E. Shaw. Francis Fairfield is in charge of resource planning. In a staff capacity, Norman R. Haynes is in charge of mission analysis and planning, and Alan S. Hirshberg is launch planning analyst. Dr. Conway W. Snyder is Mariner Project Scientist.

The project is divided into four systems:

Spacecraft
Mission Operations
Tracking and Data Acquisition
Launch Vehicle

The first three systems are assigned to the Jet Propulsion Laboratory. The fourth is assigned to NASA's Lewis Research Center, Cleveland, for the Atlas-Agena launch vehicle. Dr. Abe Silverstein is the Director of Lewis Research Center. Bruce T. Lundin is Associate Director for Development and Dr. Seymour C. Himmel is Assistant Director for Launch Vehicles. Launch operations for Lewis are directed by Kennedy Space Center (Unmanned Launch Operations) at Cape Kennedy.

A few of the many key personnel for each of the systems are listed.

Allen E. Wolfe	Spacecraft System Manager
Allan G. Conrad	Spacecraft System Engineer
Milton T. Goldfine	Spacecraft Operations Manager
James Maclay	Environmental Requirements Engineer
L. Kenneth Tate	Quality Assurance Engineer
Frank H. Wright	Reliability Programs
A. Nash Williams	Spacecraft/Launch Vehicle Integration
John J. Paulson	Space Science
Thomas C. Sorensen	Spacecraft Telecommunications
Joseph L. Savino	Spacecraft Guidance and Control
Jay D. Schmuecker	Spacecraft Engineering Mechanics
Russ Stott	Data Handling
Carl L. Thiele	Environmental Simulation Support
Thomas A. Groudle	Post-injection Propulsion and Pyrotechnics
G. Wade Earle	Spacecraft Test Conductor
David W. Douglas	Mission Operations System Manager
William E. Kirhofer	Spaceflight Operation Director
Harold J. Gordon	Flight Path Analysis and Command Director
Wilbur J. Scholey	Data Processing Operations Director
Ronald F. Draper	Spacecraft Performance Analysis and Command Director
Harold E. MacDonald	Space Science Analysis Director

Dr. Nicholas A. Renzetti	Tracking and Data Acquisition System Manager
Meredith S. Glenn	Assistant TDS Manager
Richard P. Laeser	DSN Project Engineer
H. Warren Plohr	Launch Vehicle System Manager
Elmer H. Davison	Assistant Launch Vehicle System Manager
Roy K. Hackbarth	Project Engineer
Donald E. Forney	Field Engineering Branch
Robert H. Gray	Chief of Unmanned Launch Operations (KSC)
Harold Zweigbaum	Manager of Atlas-Agena Launch Operations (KSC/ULO)

<u>Deep Space Network</u>

Dr. Eberhardt Rechtin	JPL's Assistant Director for Tracking & Data Acquisition
Dr. N. A. Renzetti	Tracking and Data System Manager for the Mariner Venus Project
Walter E. Larkin	Manager of the Goldstone complex
Dennis Willshir	Woomera station manager
Robert A. Leslie	Tidbinbilla station manager
Richard Fahnestock	JPL DSN resident in Australia
Doug Hogg	Johannesburg station manager
Robert Terbeck	JPL DSN resident in Johannesburg
Dr. Manuel Bautista Aranda	Spanish Station Director
Donald Meyer	JPL manager at Robledo facility
Joe Feary	JPL manager at Cebreros facility
Phil Tardani	JPL DSN resident in Madrid

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Launch Vehicle Contractors

The Atlas, designed and built by General Dynamics/Convair (GD/C), San Diego, Calif., is purchased through the Space Systems Division of the U.S. Air Force Systems Command. Rocketdyne Division of North American Aviation, Inc., of Canoga Park, Calif., builds the propulsion system. Radio command guidance is by the Defense Division of General Electric Co. and ground guidance computer by the Burroughs Corp.

Some of the key General Dynamics personnel are Grant L. Hansen, vice president and program director for space launch vehicles; Jim Von Der Wische, project manager for the Mariner mission; K. E. Newton, manager of ETR launch operations; Orior H. Reed, chief of launch operations; and Tom Chitty, launch conductor.

The Agena D stage and its mission modifications are purchased directly by the Lewis Center from Lockheed Missiles and Space Co. (LMSC), Sunnyvale, Calif. Bell Aerosystems Co., Buffalo, N.Y., provides the propulsion system. Ray C. Kent is assistant general manager of LMSC for medium space vehicles; John J. Kennelly, LMSC program manager for NASA satellites and probes; Malcolm E. Avery, chief system engineer, Mariner program; and Bud Zeller is Agena test director.

Spacecraft Subcontractors

A list of some key subcontractors to the Jet Propulsion Laboratory who provided instruments and hardware for the Mariner Venus 67 follows. Many of the items were procured for the Mariner Mars 64 mission and some have been modified or reworked for this application.

Advanced Structures Division Whittaker Corp. La Mesa, Calif.	spacecraft hi-gain antennas
Airrite Products Division of Electrada Corp. Los Angeles, Calif.	midcourse propulsion fuel tanks, nitrogen tanks
Alpha-Tronics Corp. Monrovia, Calif.	data automation subsystem analog-to-pulse width converters
Anadite Co. Los Angeles, Calif.	surface treatment of structural elements and chassis

Anchor Plating Co. El Monte, Calif.	gold plating
Applied Development Corp. ADC Product Division Canoga Electronics Chatsworth, Calif.	ground telemetry de- commutators, printer- programmers
Astrodata, Inc. Anaheim, Calif.	ground command read-write- verify equipment, encoder simulator, and data input subsystem for spacecraft system test data system
Bendix Corp. Scintilla Division Santa Ana, Calif.	connectors
Bergman Manufacturing Co. San Rafael, Calif.	chassis forgings
Cannon Electric Co. Los Angeles, Calif.	connectors
CBS Laboratories Division of Columbia Broadcasting System, Inc. Stamford, Conn.	image dissector tubes for Canopus star sensor
Cinch Manufacturing Co. Chicago, Ill.	connectors
Computer Control Co., Inc. Framingham, Mass.	logic cards for science operations support equipment
Correlated Data Systems Corp. Glendale, Calif.	spacecraft external power source and solar panel simulators
Data-tronix Corp. King of Prussia, Pa.	ground telemetry voltage controlled oscillators
Digital Equipment Corp. Los Angeles, Calif.	data automation subsystem operations support equipment
Dunlap & Whitehead Manufacturing Co. Van Nuys, Calif.	midcourse propulsion and structural elements

Dynamics Instrumentation Co. Monterey Park, Calif.	ground telemetry sets
The Electric Storage Battery Co. Raleigh, N.C.	batteries
Electro-Development Co. Division of Teledyne Precision Van Nuys, Calif.	battery chargers
Electro-Instruments, Inc. Glendale, Calif.	power subsystem operational support equipment
Electro-Mechanical Research Princeton Junction, N.J.	ultraviolet photometer photomultiplier tubes
Electro-Optical Systems, Inc. Pasadena, Calif.	solar panels, rework and test of power subsystems
Electronic Memories, Inc. Los Angeles, Calif.	central computer and sequencer magnetic counter assemblies
Engineered Magnetics Division of Gulton Industries, Inc. Hawthorne, Calif.	radio power amplifier power supplies and data automation subsystem AC-to-DC power converters
Fargo Rubber Co. Los Angeles, Calif.	midcourse propulsion fuel tank bladders
Franklin Electronics Bridgeport, Pa.	ground telemetry high speed digital printers
Grindley Manufacturing Co. Los Angeles, Calif.	midcourse propulsion jet vanes, fuel manifolds, oxidizer tank shell and supports
Hi-Shear Corp. Torrance, Calif.	pyrotechnic subsystem squibs
Hughes Aircraft Co. Microwave Tube Division Los Angeles, Calif.	radio subsystem traveling wave tubes
International Data Systems, Inc. Dallas, Tex.	ground command modulation checker, ground telemetry power supplies

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Kearfott Division General Precision, Inc. Los Angeles, Calif.	gyroscopes, jet vane actuators
Labko Scientific, Inc. Stillwater, Okla.	ultraviolet photometers
Litton Systems, Inc. Guidance and Control Systems Division Woodland Hills, Calif.	data automation subsystems and associated bench checkout equipment
Lockheed Electronics Co. Division of Lockheed Aircraft Co. Los Angeles, Calif.	central computer and sequencer magnetic shift registers
Magnamill Los Angeles, Calif.	structural elements and chassis
Massachusetts Institute of Technology Division of Sponsored Research Cambridge, Mass.	plasma probes
Maury Microwave Corp. Montclair, Calif.	hi-gain and lo-gain antenna monitors, rf directional couplers, TWT attenuators
Metal Bellows Corp. Chatsworth, Calif.	midcourse propulsion oxidizer bellows assembly
Millbore Co. Glendale, Calif.	midcourse propulsion engine components
Mincom Division Minnesota Mining and Manufacturing Co. Caramillo, Calif.	ground telemetry tape recorders
Motorola, Inc. Military Electronics Division Scottsdale, Ariz.	radio subsystem transponders, command subsystems and associated operational support equipment
Northrop Corp. Northrop Space Laboratories Hawthorne, Calif.	screening inspection of electronic component parts

Optical Coating Laboratory Santa Rosa, Calif.	solar cell cover slips
Philco Corp. Palo Alto, Calif.	integrated circuit sequence generator system, antenna feeds
Proto Spec Pasadena, Calif.	chassis and subchassis
Pyrotechnics, Inc. Santa Fe Springs, Calif.	midcourse propulsion explosive-actuated valves
Rantec Corp. Calabasas, Calif.	radio subsystem circulator switches, pre-selection and band pass filters
Raymond Engineering Laboratory, Inc. Middletown, Conn.	spacecraft tape recorders
Ryan Aeronautical Co. San Diego, Calif.	solar panel structures
Siemens and Halske AG Munich, West Germany	radio amplifier tubes
Signetics Corp. Palo Alto, Calif.	integrated circuits
Sperry Utah Co. Division of Sperry Rand Corp. Salt Lake City, Utah	magnetometer mapping fixture
Stanford University Stanford, Calif.	dual frequency receivers
University of Iowa Iowa City, Iowa	trapped radiation detectors
Sterer Engineering and Manufacturing Co. North Hollywood, Calif.	attitude control gas system valves and regulators
Texas Instruments, Inc. Apparatus Division Dallas, Tex.	spacecraft tape recorder electronics, data encoders and associated operational support equipment, helium magnetometers, attitude control gyro electronics assemblies, data demodulators

Textron Electronics, Inc. Heliotek Division Sylmar, Calif.	silicon photovoltaic solar cells
Trans-Sonics Burlington, Mass.	telemetry pressure and temperature transducers
TRW Systems, Inc. Redondo Beach, Calif.	central computer and sequencer and associated operational support equipment, thermal control louvers
University of Colorado Boulder, Colo.	calibration of ultraviolet photometers
Wems, Inc. Hawthorne, Calif.	data automation subsystem analog-to-pulse width converters, attitude control electronic modules
Wyman Gordon Corp. Los Angeles, Calif.	structural forgings

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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WO 3-6925

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Addenda

NOTE TO EDITORS:

Since the enclosed press kit on the launch of Mariner Venus 67 was printed, a decision was made to change the launch date.

The launch period will begin on June 14, 1967, not on June 12 as stated.

The change was made when trajectory engineers calculated that the later launch date would improve the orbit at the encounter with the planet for obtaining scientific information.

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5/26/67